



US007786268B2

(12) **United States Patent**
Fischer et al.

(10) **Patent No.:** **US 7,786,268 B2**
(45) **Date of Patent:** **Aug. 31, 2010**

(54) **ANTI-IP-10 ANTIBODIES AND METHODS OF USE THEREOF**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 227 days.

(21) Appl. No.: **12/072,824**

(22) Filed: **Feb. 28, 2008**

(65) **Prior Publication Data**

US 2009/0169561 A1 Jul. 2, 2009

Related U.S. Application Data

(60) Provisional application No. 60/904,265, filed on Feb. 28, 2007.

(51) **Int. Cl.**

C07K 16/00 (2006.01)

A61K 39/395 (2006.01)

A61K 38/00 (2006.01)

(52) **U.S. Cl.** **530/387.1**; 530/388.1; 530/388.15; 530/388.23; 424/130.1; 424/132.1; 424/133.1; 424/141.1; 424/142.1; 424/158.1

(58) **Field of Classification Search** None
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2003/0166589	A1	9/2003	Karin	514/44
2004/0096446	A1	5/2004	Lane	424/145.1
2004/0191255	A1	9/2004	Lillard et al.	424/145.1
2005/0025744	A1	2/2005	Lane	424/85.6
2005/0191293	A1	9/2005	Deshpande et al.	424/143.1
2008/0019973	A1	1/2008	Lane et al.	424/145.1
2008/0063646	A1	3/2008	Balasa et al.	424/158.1
2009/0081787	A1	3/2009	Yoneyama et al.	435/375

FOREIGN PATENT DOCUMENTS

WO	WO 02/15932	2/2002
WO	WO 02/098346	12/2002
WO	WO 03/006045	1/2003

WO	WO 2004/045525	6/2004
WO	WO 2004/082714	9/2004
WO	WO 2004/101511	11/2004
WO	WO 2005/023201	3/2005
WO	WO 2005/058815	6/2005
WO	WO 2005/060457	7/2005
WO	WO 2006/118085	11/2006
WO	WO 2008/044824	4/2008

OTHER PUBLICATIONS

PipelineReview.com:NovImmune successfully completes NI-0801 Phase I clinical study. Jul. 13, 2009. p. 1.*
 Chothia et al., "Conformations of immunoglobulin hypervariable regions," Nature, vol. 342:877-883 (1989).
 Arai et al., "IP-10 and Mig Facilitate Accumulation of T Cells in the Virus-Infected Liver," Cellular Immunol., vol. 219:48-56 (2002).
 Christen et al., "Among CXCR3 Chemokines, IFN-gamma-Inducible Protein of 10 kDa (CXC Chemokine Ligand (CXCL) 10) but not Monokine Induced by IFN-gamma (CXCL9) Imprints a Pattern for the Subsequent Development of Autoimmune Disease," J. of Immunol., vol. 171:68386845 (2003).
 Dufour et al., "INF-gamma-Inducible Protein 10 (IP-10; CXCL10)-Deficient Mice Reveal a Role for IP-10 in Effector T Cell Generation and Trafficking," J. of Immunol., vol. 168:3195-3204 (2002).
 Liu et al., "Chemokine Receptor CXCR3: An Unexpected Enigma," Current Topics in Developmental Biology, vol. 68:149-181 (2005).
 Liu et al., "Neutralization of the Chemokine CXCL10 Reduces Inflammatory Cell Invasion and Demyelination and Improves Neurological Function in a Viral Mode of Multiple Sclerosis," J. of Immunol., vol. 167: 4091-4097 (2001).
 Tannenbaum et al., "The CXC Chemokines IP-10 and Mig are Necessary for IL-12-Mediated Regression of the Mouse RENCA Tumor," J. of Immunol., vol. 161:927-932 (1998).

* cited by examiner

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(57) **ABSTRACT**

The invention relates to fully human antibodies, and fragments thereof, that bind to interferon-inducible-protein-10 (IP-10, CXCL10), thereby modulating the interaction between IP-10 and its receptor, CXCR3, and/or modulating the biological activities of IP-10. The invention also relates to the use of such anti-IP-10 antibodies in the prevention or treatment of immune-related disorders and in the amelioration of one or more symptoms associated with an immune-related disorder.

11 Claims, 13 Drawing Sheets

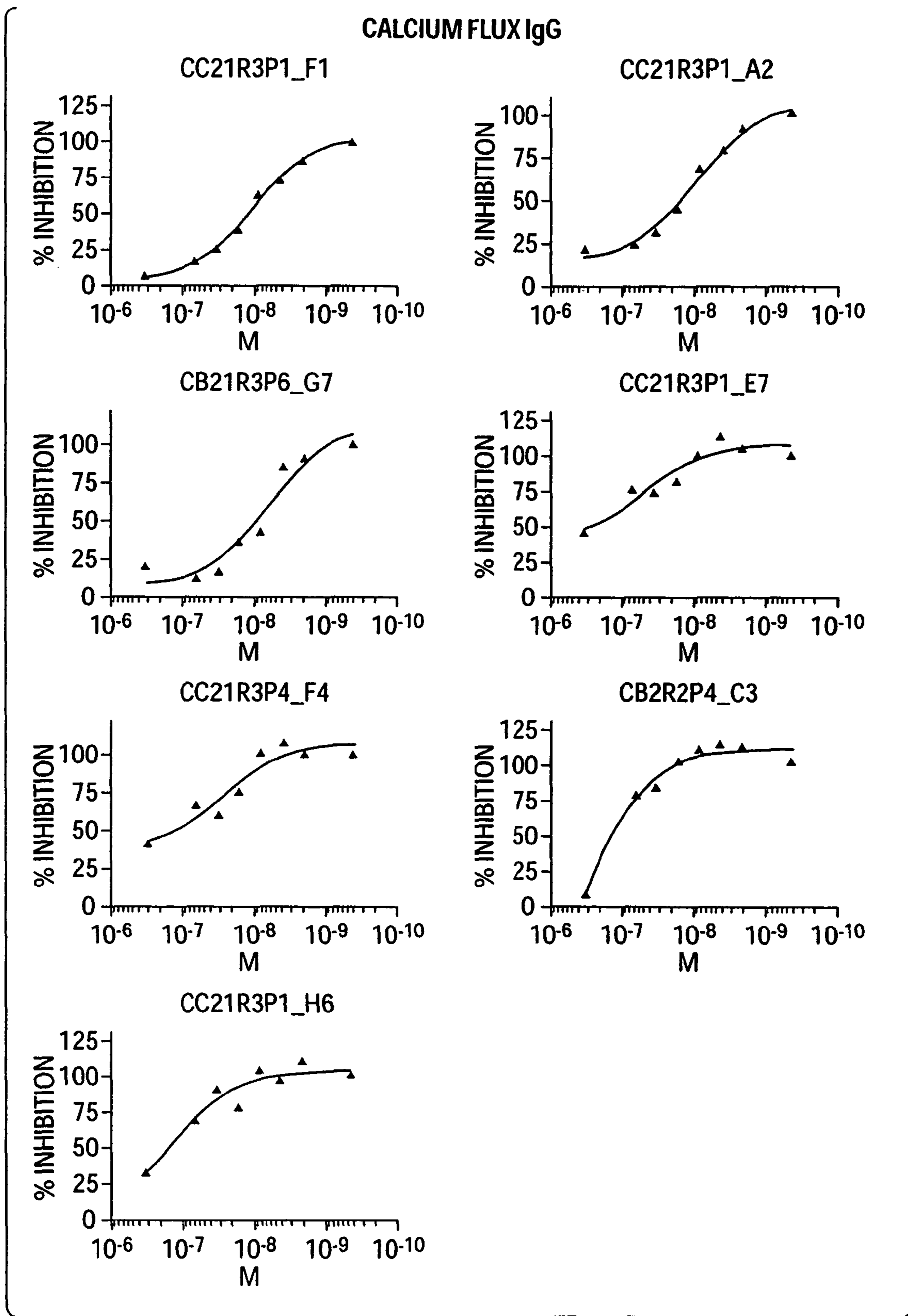


Fig. 1A

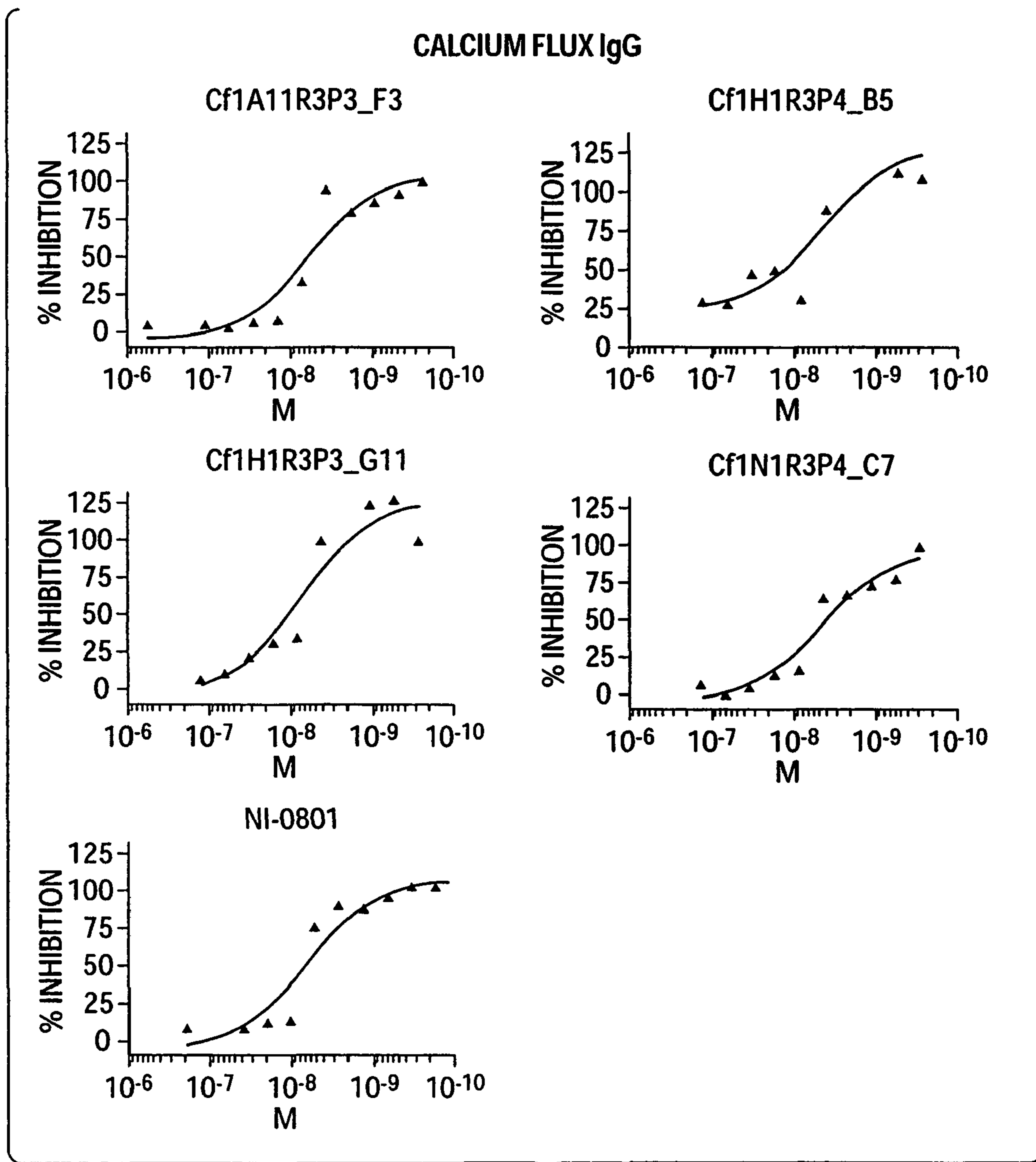


Fig. 1B

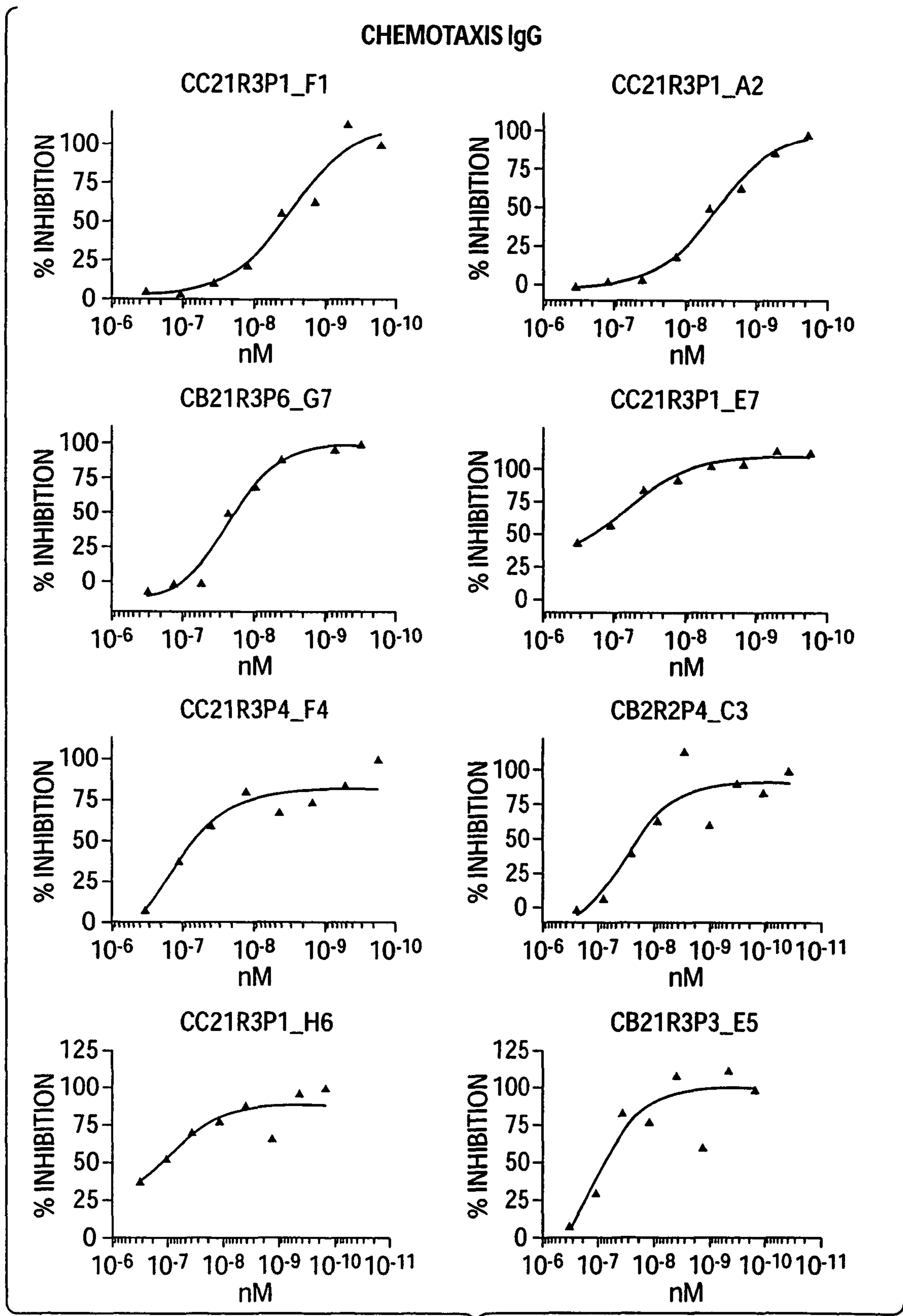


Fig. 2A

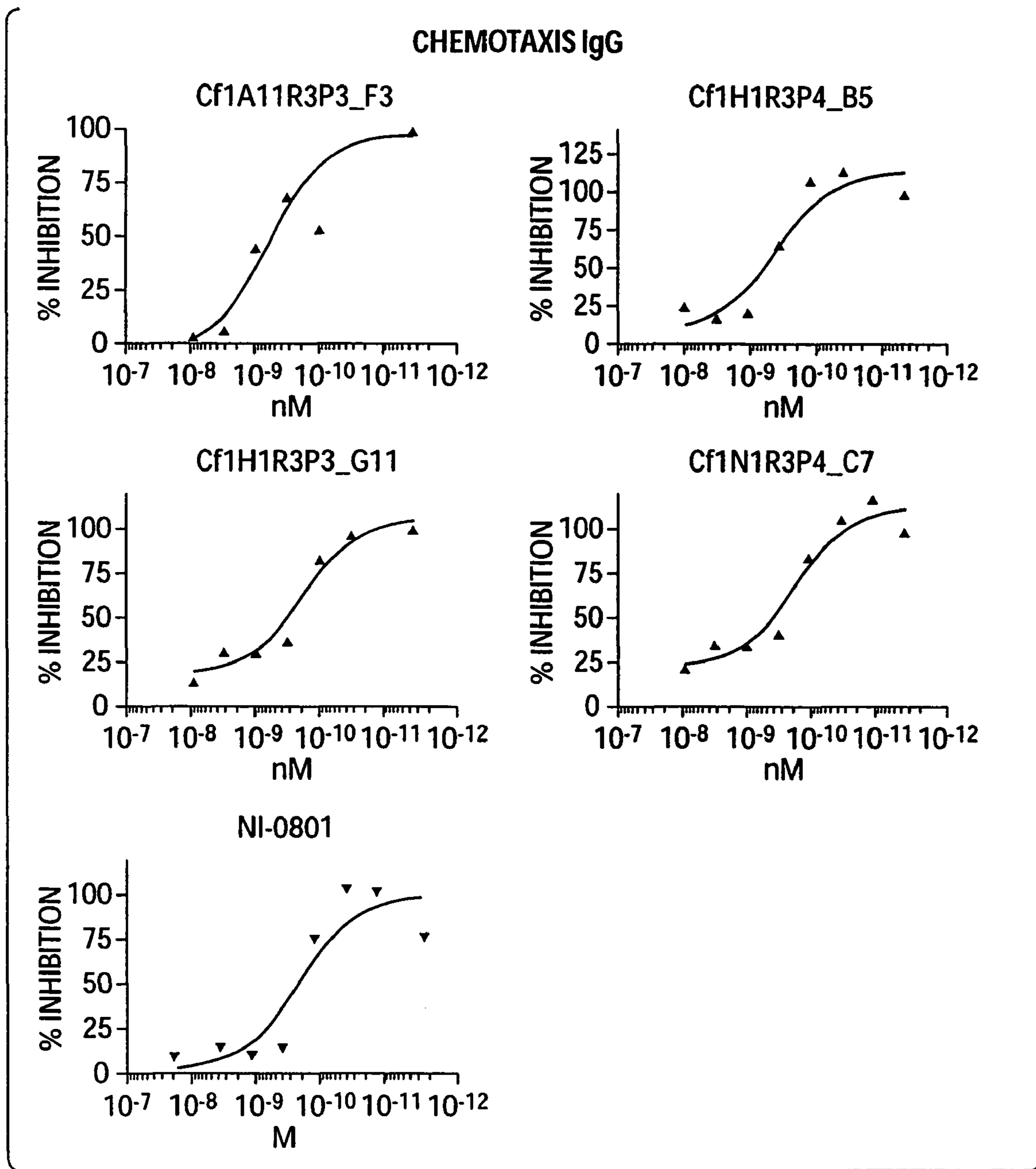


Fig. 2B

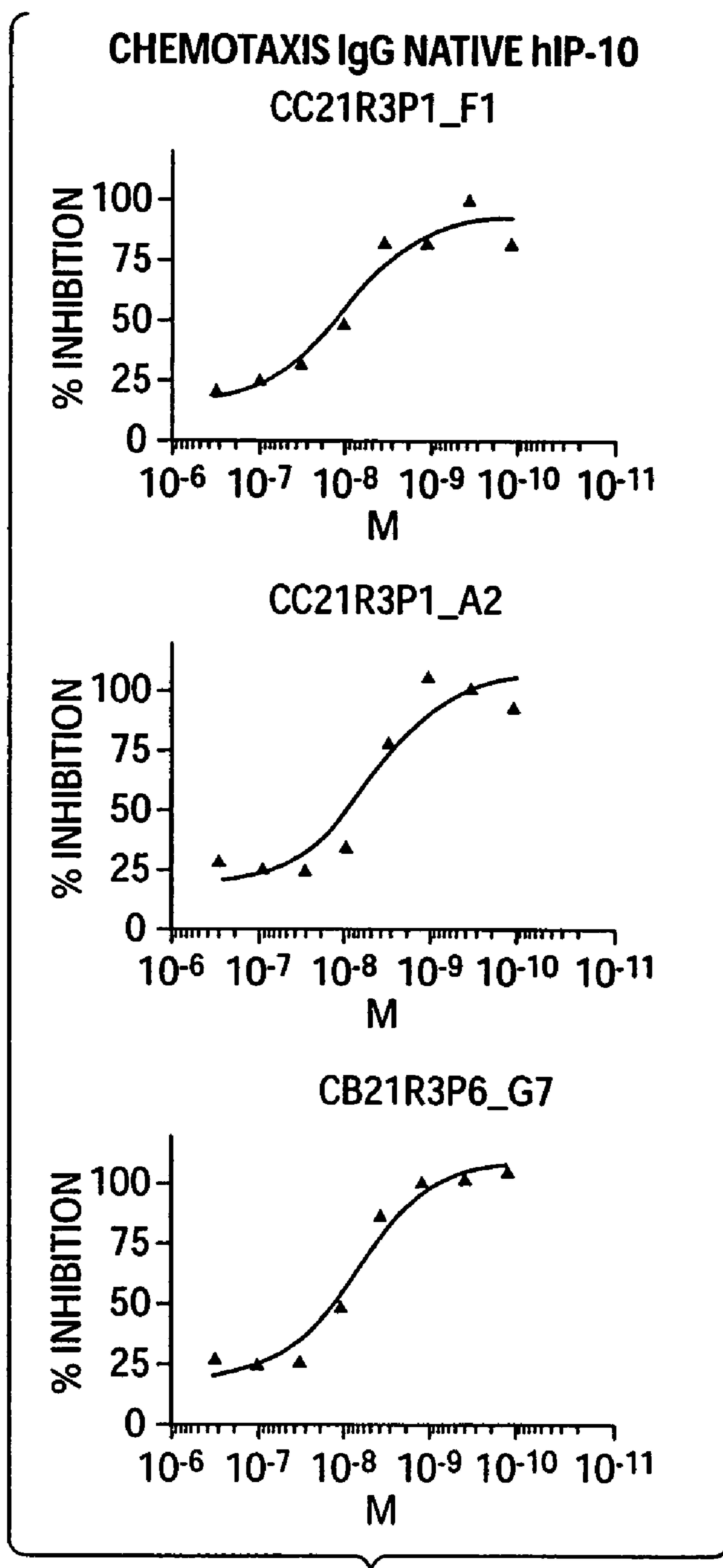


Fig. 3A

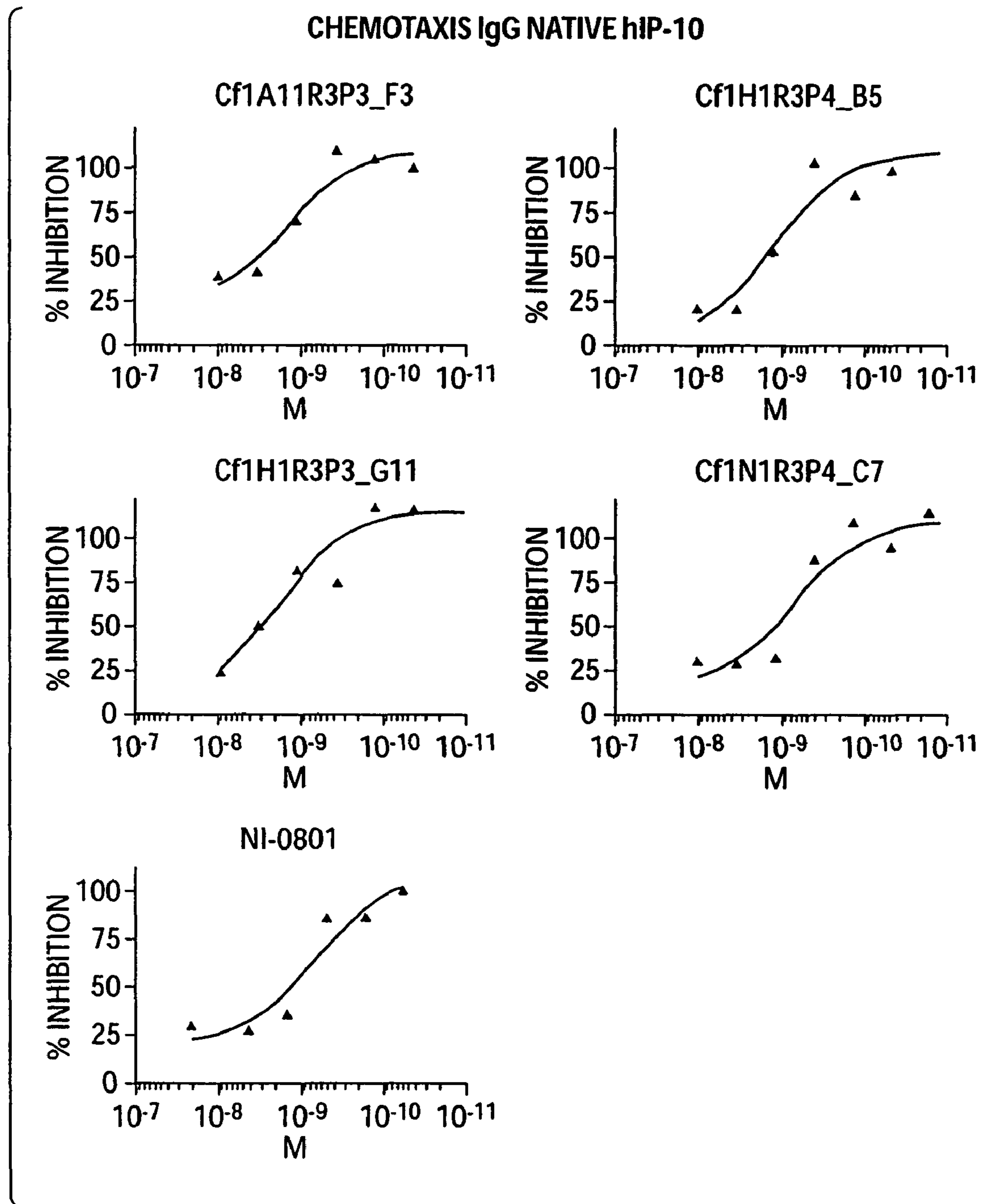


Fig. 3B

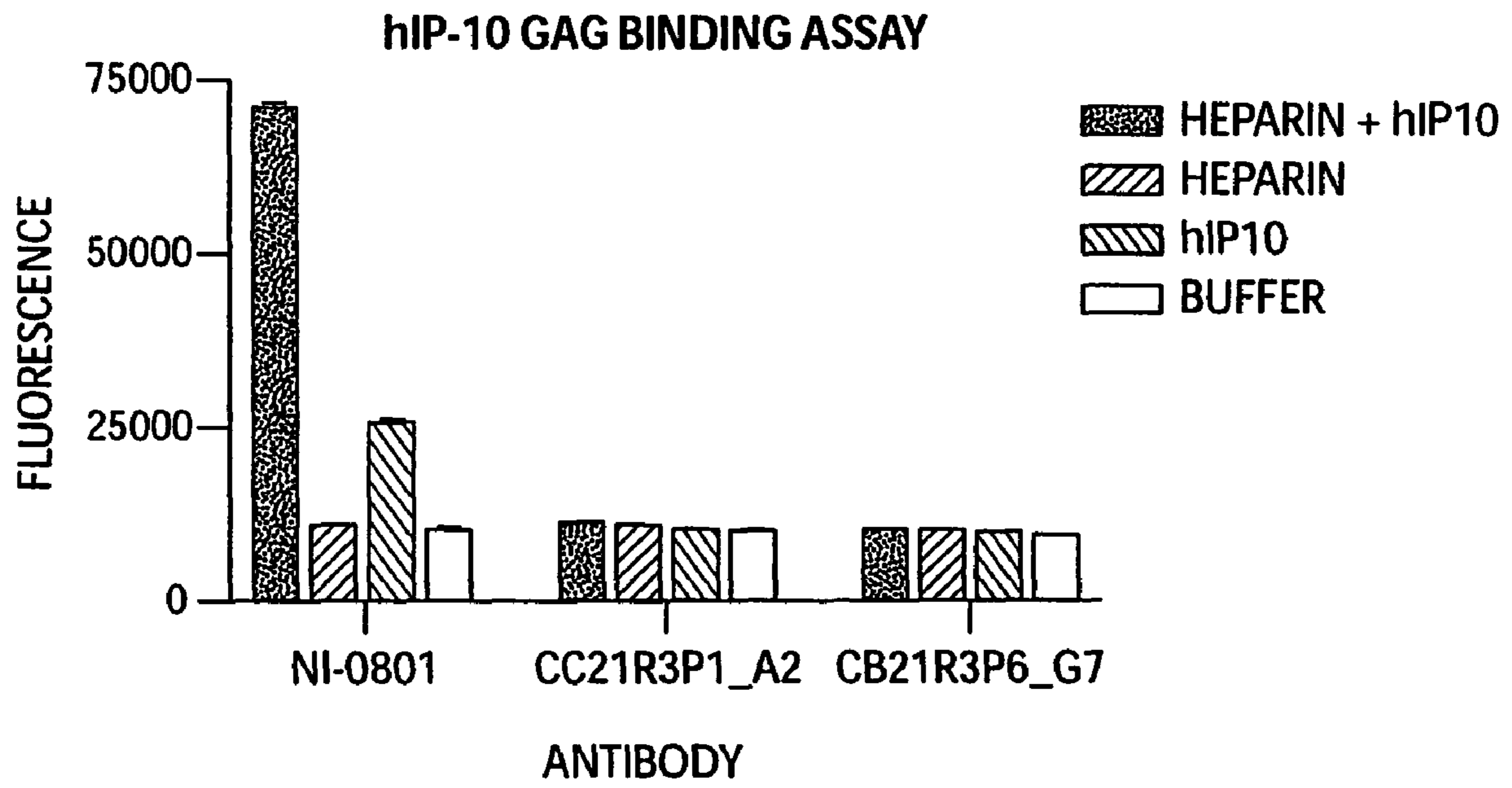


Fig. 4

VH	FW1	CDR1	FW2	CDR2
NI-0801	QVQLVESGGGVQPGRSLRLSCAASGFTFSN	SGTH-----	WVRQAPGKGLEWVAVISY-----	DGSNKYYADSVKGRFTISRDNSKNTLYL
Cf1N1R3P4_C7	QVQLVESGGGVQPGRSLRLSCAASGFTFSN	SGJH-----	WVRQAPGKGLEWVAVISY-----	DGSNKYYADSVKGRFTISRDNSKNTLYL
DP-49	QVQLVESGGGVQPGRSLRLSCAASGFTFSY	GMMH-----	WVRQAPGKGLEWVAVISY-----	DGSNKYYADSVKGRFTISRDNSKNTLYL
VH	FW3	CDR3	FW4	
NI-0801	QMNSL--RAEDTAVYYCARLRDIAEYT-----		DYWGQGLTVTVSS.	
Cf1N1R3P4_C7	QMNSL--RAEDTAVYYCALKLRDIAEYT-----		DYWGQGLTVTVSS.	
DP-49	QMNSL--RAEDTAVYYCAR.....			
VL	FW1	CDR1	FW2	CDR2
NI-0801	NFMLTQPHS-VSESPGKTVTISCTIGSGGS-----		IASNYYQWYQQRPGSSPTTVIYED-----	NQRPSGVPDRFSGSIDSNS
Cf1N1R3P4_C7	NFMLTQPHS-VSESPGKTVTISCTIGSGGS-----		IDBNYYQWYQQRPGSSPTTVIYED-----	NQRPSGVPDRFSGSIDSNS
IGLV6-57	NFMLTQPHS-VSESPGKTVTISCTRSSGS-----		IASNYYQWYQQRPGSSPTTVIYED-----	NQRPSGVPDRFSGSIDSNS
VL	FW3	CDR3	FW4	
NI-0801	ASLTISGLKTEDEADYYCQSYDPLPV-----		WVFGGGTKLTV---LG..	
Cf1N1R3P4_C7	ASLTISGLKTEDEADYYCQSYDPLPV-----		WVFGGGTKLTV---LG..	
IGLV6-57	ASLTISGLKTEDEADYYCQSYD.....			

Fig. 5

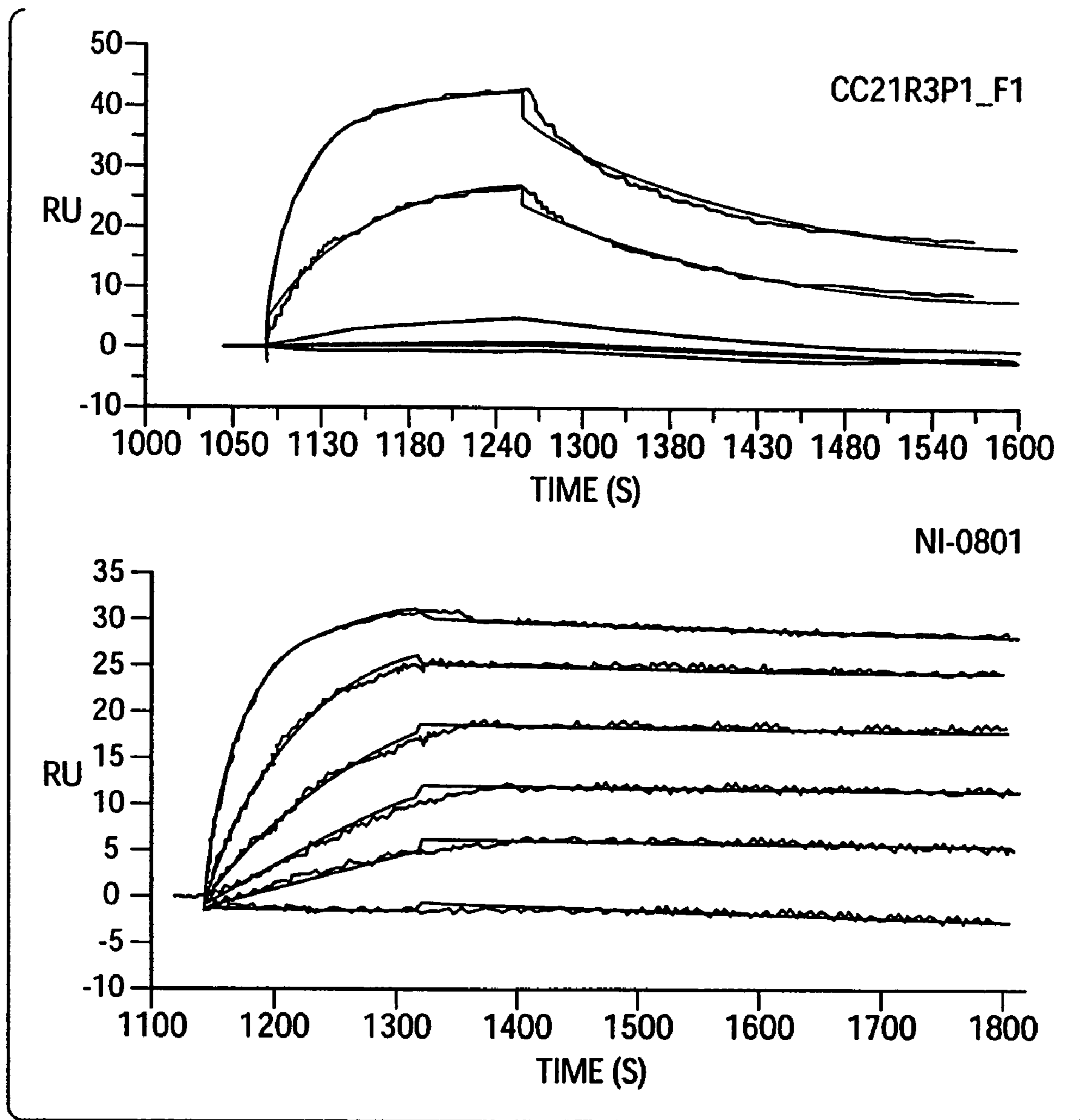


Fig. 6

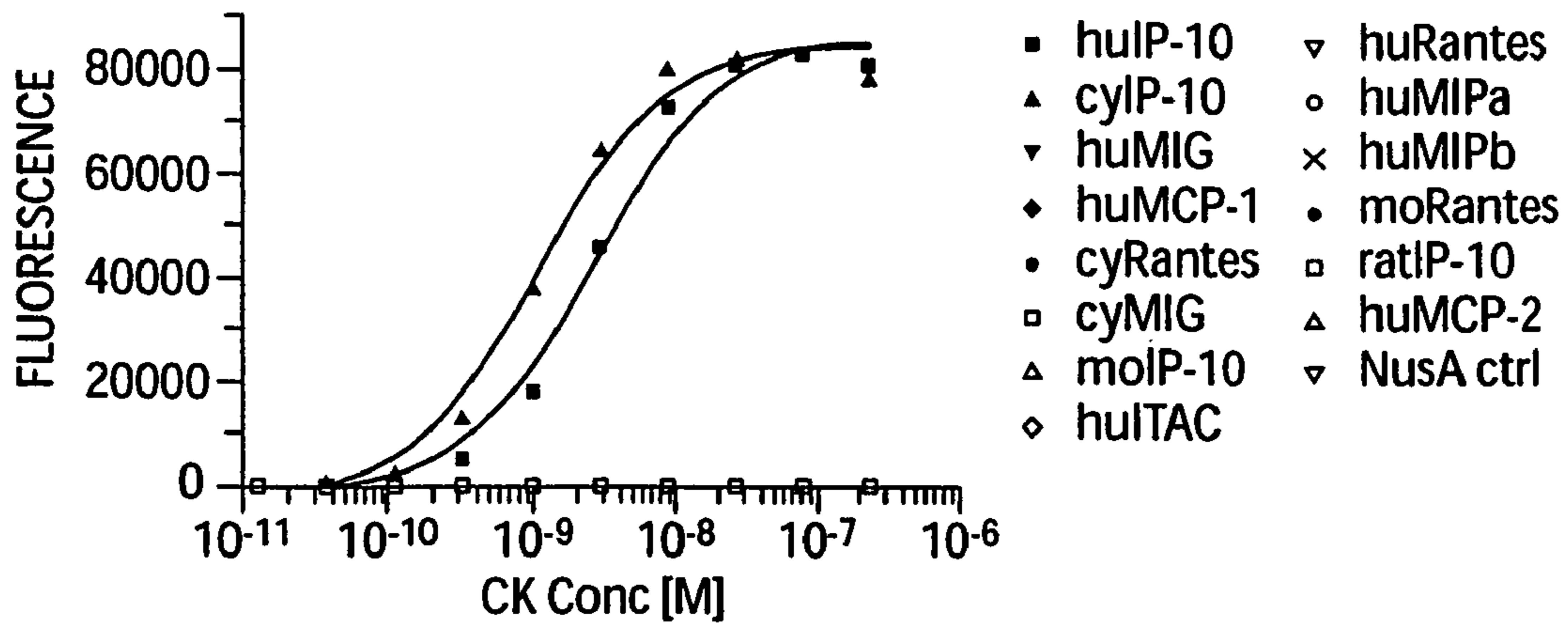


Fig. 7

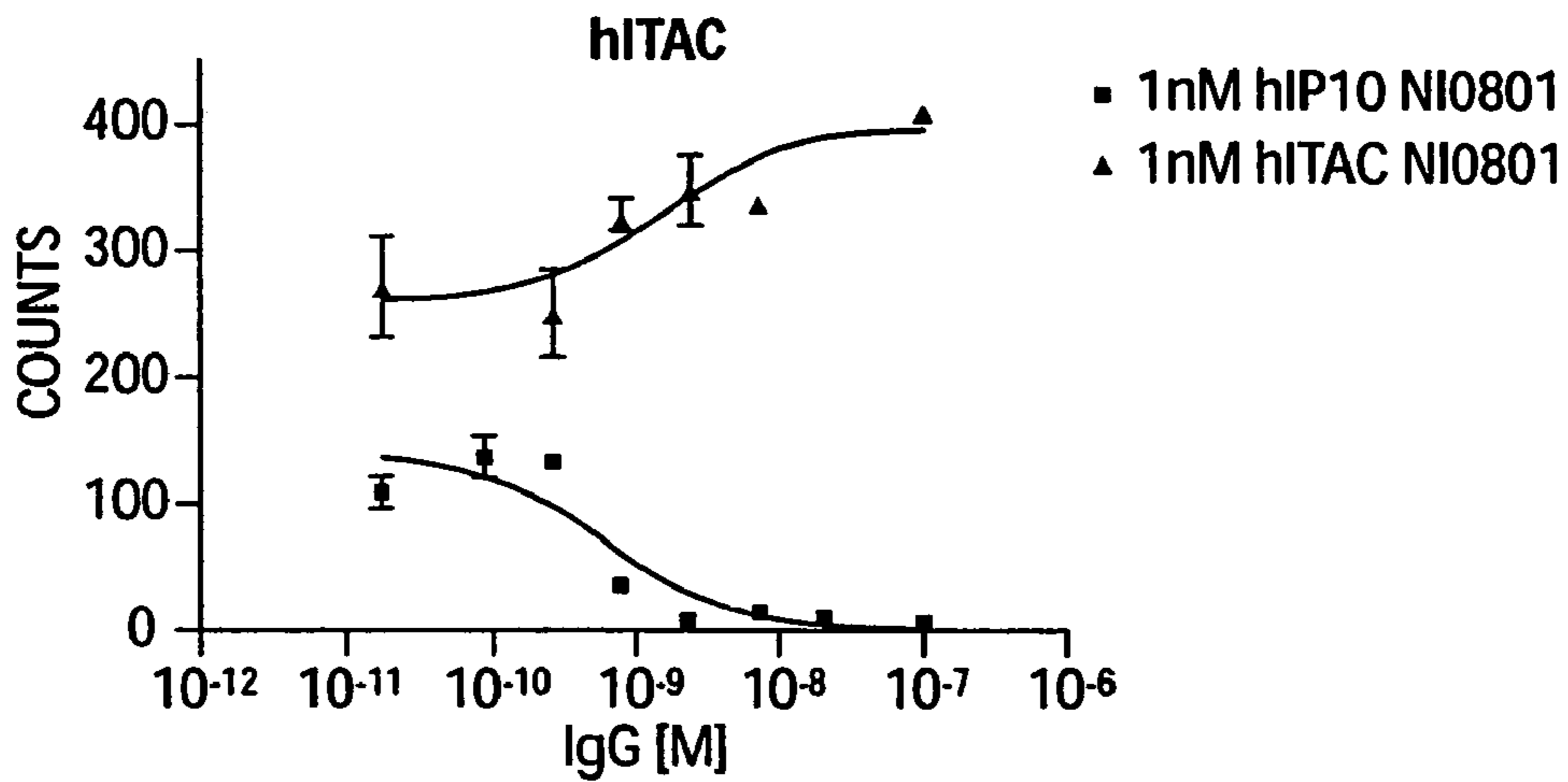


Fig. 8A

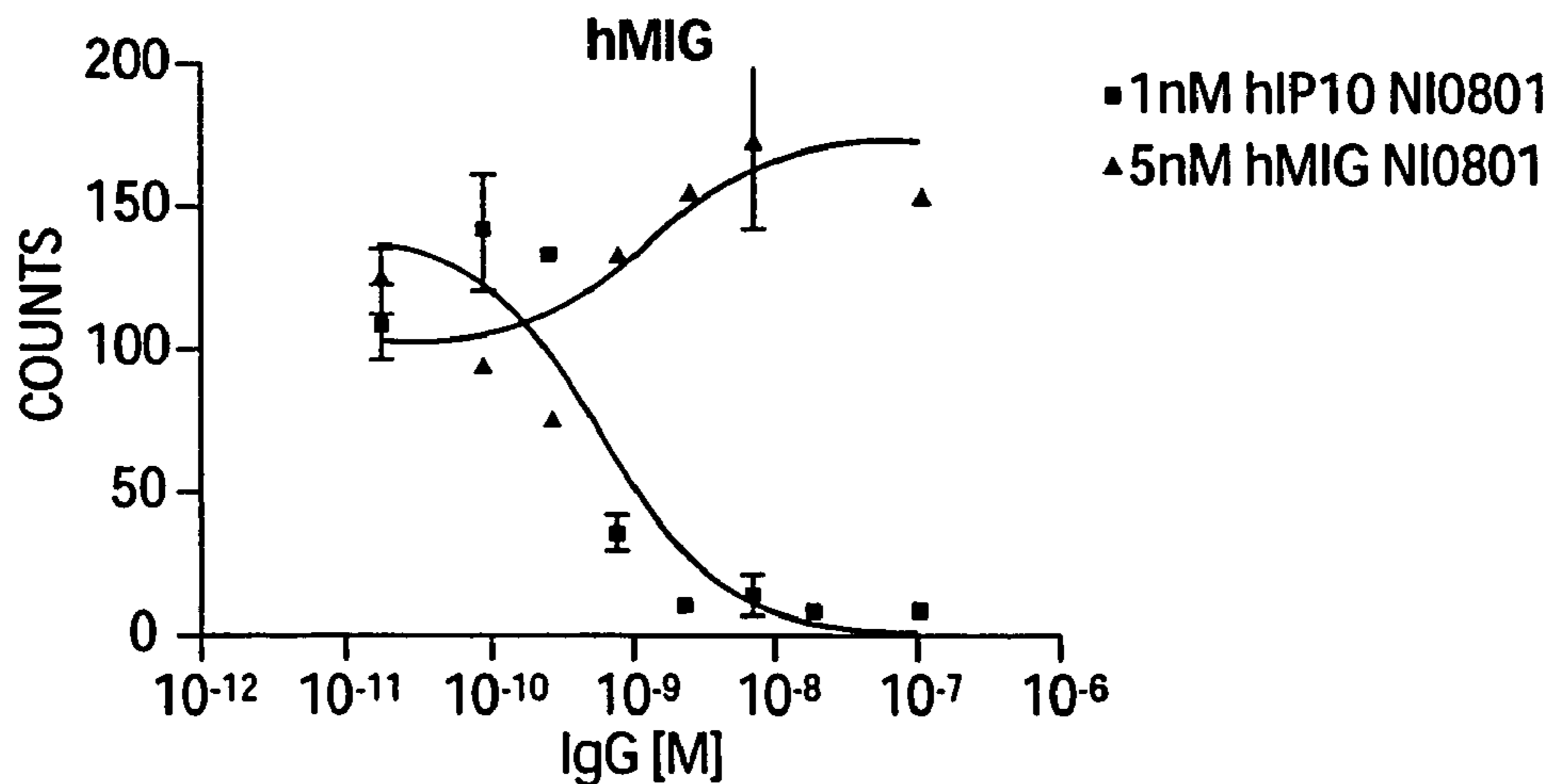


Fig. 8B

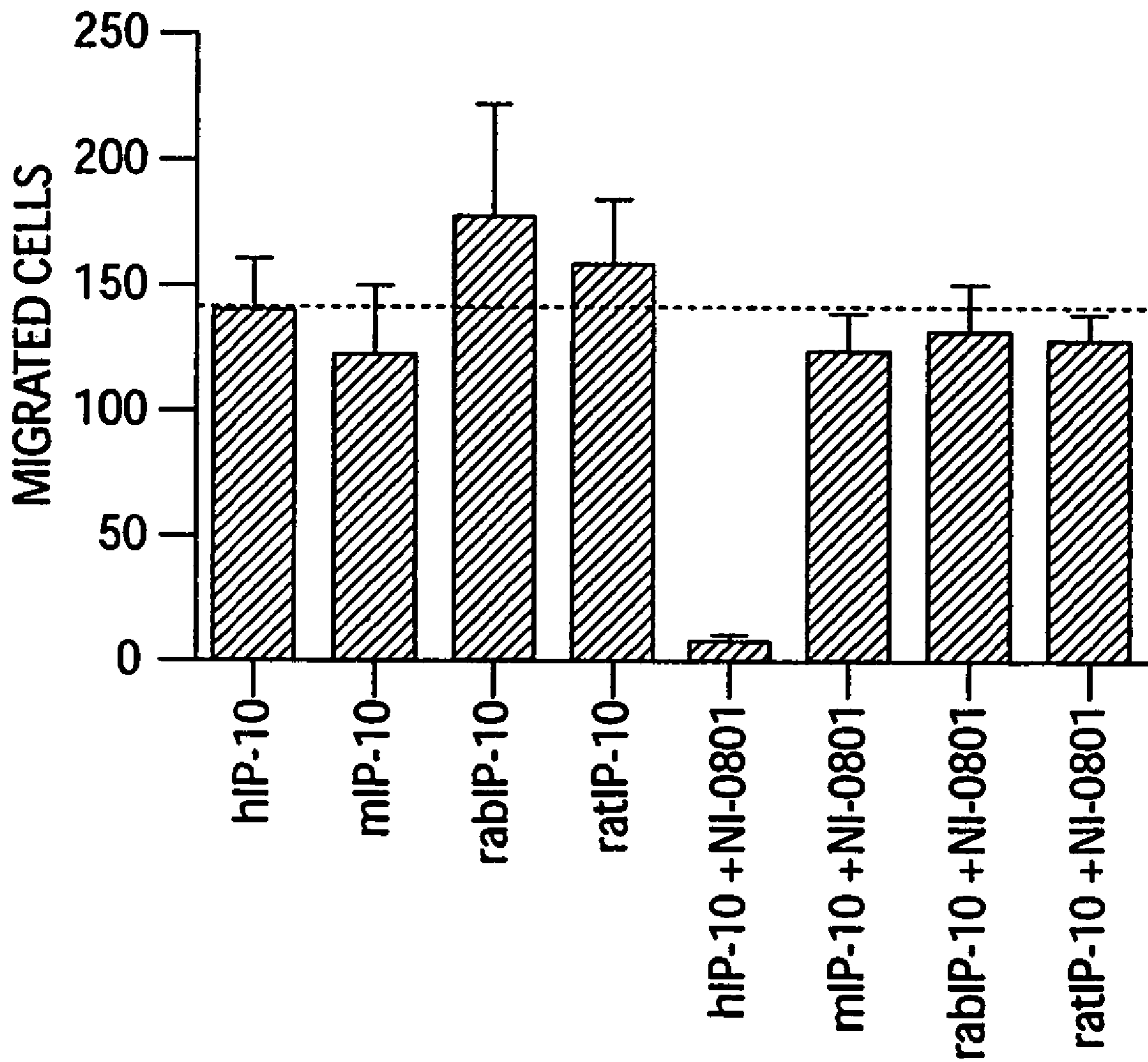


Fig. 9

LADDER	10	20	30	40	50	60	70	80						
HUMAN	VPLSRTVRC	TCISIS	SNQPVN	PRSLEKLEI	PASQFC	PRVEI	IATMKK	KGKRC	LNPE	SKA	KNLL	KAVS	KERS	KRSP
CYNO	IPLSRTVRC	TCISIS	SNQPVN	PRSLEKLEI	PPSQFC	PHVEI	IATMKK	KGKRC	LNPE	SKA	KNLL	KAVS	KERS	KRSP
RHESUS	IPLSRTVRC	TCISIS	SNQPVN	PRSLEKLEI	PPSQFC	PHVEI	IATMKK	KGKRC	LNPE	SKA	KNLL	KAVS	KERS	KRSP
RABBIT	MPLSRTVRC	TCININ	SNKPVN	PRSLEKLEI	PASQSC	ANVEI	IATMKK	DGKRC	LNPE	KA	KNLL	KAF	SKERS	GRSS
DOG	IPLSRTVRC	TCIKIS	SDQPVN	RSLEKLEM	PASQSC	PHVEI	IATMKK	SGKRC	LNPE	SKT	KS	LVKA	SKRS	RRSP
PIG	IPLSRTVRC	TCIKIS	DRPVN	PRSLEKLEM	PASQSC	PHVEI	IATMKK	NGKRC	LNPE	SKA	KNLL	KAI	SKERS	KRSP
RAT	IPLARTVRC	TCIDF	HEQ	LRPRA	IGKLEI	PASQSC	PHVEI	IATMKK	NEKRC	LNPE	SEA	KS	LLKAVS	QR
MOUSE	IPLARTVRC	TCININ	DDG	PVRA	IGKLEI	PASQSC	PRVEI	IATMKK	NEKRC	LNPE	SKT	KN	LMKA	F
GOAT	IPLSRTVRC	TCIEIS	NGSM	PRSLEKLEI	PASQSC	PRVEI	IATMKR	NGKRC	LNPE	SKT	KN	LLKAI	NKQRT	KRSP
COTTON RAT	IPLSRTVRC	TCIFC	NK	TE	DR	LRPRA	LEKLEI	PASQSC	PRMEI	IATMKK	TE	KKRC	LNPE	SEA
HAMSTER	IPLSRTVRC	TCIKID	DRPV	KPRAL	IGKLEI	PASQSC	PRVEI	IATMKK	TE	KKRC	LNPE	SEA	KS	LLKAVS
LADDER	10	20	30	40	50	60	70	80						

Fig. 10

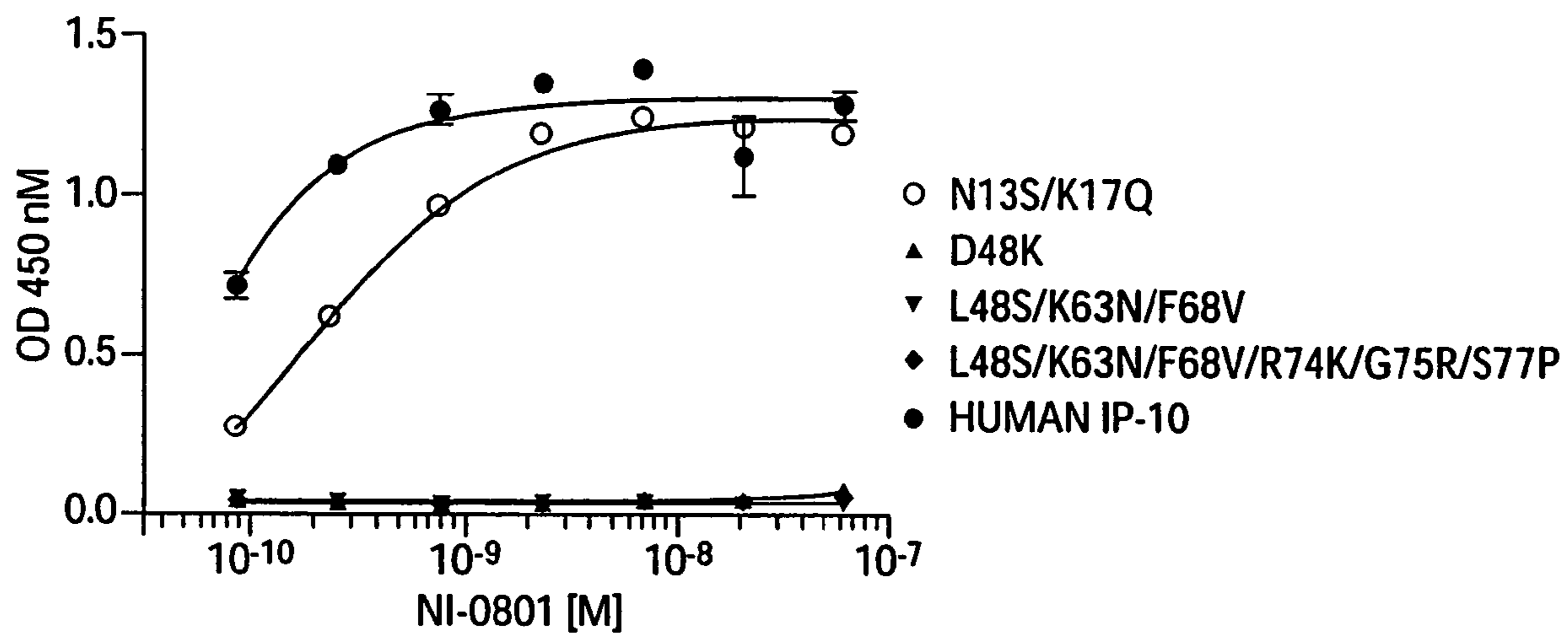


Fig. 11

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ANTI-IP-10 ANTIBODIES AND METHODS OF USE THEREOF

RELATED APPLICATIONS

This application claims the benefit of and priority to U.S. Patent Application No. 60/904,265, filed Feb. 28, 2007, which is hereby incorporated by reference in its entirety.

FIELD OF THE INVENTION

This invention relates generally to fully human anti-IP-10 monoclonal antibodies as well as to methods for use thereof.

BACKGROUND OF THE INVENTION

Interferon-inducible protein-10 (IP-10, CXCL10) is a CXC chemokine that signals through the CXCR3 receptor. IP-10 selectively chemoattracts Th1 lymphocytes and monocytes, and inhibits cytokine-stimulated hematopoietic progenitor cell proliferation. IP-10 was originally identified as an IFN-g-inducible gene in monocytes, fibroblasts and endothelial cells. It has since been shown that IP-10 mRNA is also induced by LPS, IL-1b, TNF-a, IL-12 and viruses. Additional cell types that have been shown to express IP-10 include activated T-lymphocytes, splenocytes, keratinocytes, osteoblasts, astrocytes and smooth muscle cells.

Elevated levels of IP-10 expression has been implicated in a variety of diseases and disorders. Accordingly, there exists a need for therapies that target IP-10 activity.

SUMMARY OF THE INVENTION

The present invention provides fully human monoclonal antibodies that specifically bind interferon inducible protein 10 (IP-10, also referred to herein as CXCL10). Exemplary monoclonal antibodies include NI-0801; CF1N1R3P4_C7 ("C7"); CF1H1R3P3_G11 ("G11"); CF1H1R3P4_B5 ("B5"); CF1A11R3P3_F3 ("F3"); CC21R3P1_F1 ("CC_F1"); CB21R3P3_E5 ("E5"); CC21R3P1_H6 ("H6"); CC21R3P5_C5 ("C5"); CB1R3P4_D3 ("D3"); CB2R2P4_C3 ("C3"); CC21R3P4_F4 ("F4"); CC21R3P1_C1a ("C1a"); CC21R3P3_C1 ("C1"); CC21R3P1_E7 ("E7"); CE7C1R3H8_J9 ("J9"); CB21R3P1_F1 ("CB_F1"); CC21R3P1_A2 ("A2"); CB21R3P6_G7 ("G7"); and CC21R3P1_B9 ("B9").

Alternatively, the monoclonal antibody is an antibody that binds to the same epitope as NI-0801, C7, G11, B5, F3, CC_F1, E5, H6, C5, D3, F4, C1a, C1, E7, J9, CB_F1, A2, G7, C3, or B9. The antibodies are respectively referred to herein as huIP-10 antibodies.

huIP-10 antibodies of the invention also include antibodies that include a heavy chain variable amino acid sequence that is at least 90%, 92%, 95%, 97%, 98%, 99% or more identical the amino acid sequence of SEQ ID NO: 2, 12, 18, 26, 31, 41,

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51, 54, 61, 68, 75, 83, 92, 102, 109, 116, 123 or 137 and/or a light chain variable amino acid that is at least 90%, 92%, 95%, 97%, 98%, 99% or more identical the amino acid sequence of SEQ ID NO: 4, 14, 23, 28, 33, 43, 56, 63, 70, 77, 85, 94, 104, 111, 118, 125, 139 or 145.

Preferably, the three heavy chain complementarity determining regions (CDRs) include an amino acid sequence at least 90%, 92%, 95%, 97%, 98%, 99% or more identical to each of: (i) a V_H CDR1 sequence selected from the group consisting of SEQ ID NOs: 5, 34, 44, 64, 86, 95 and 127; (ii) a V_H CDR2 sequence selected from the group consisting of SEQ ID NOs: 6, 15, 35, 45, 65, 87, 96 and 128; (iii) a V_H CDR3 sequence selected from the group consisting of SEQ ID NOs: 7, 21, 36, 46, 52, 57, 66, 78, 88, 97, 105, 129, 132 and 140; and a light chain with three CDR that include an amino acid sequence at least 90%, 92%, 95%, 97%, 98%, 99% or more identical to each of (iv) a V_L CDR1 sequence selected from the group consisting of SEQ ID NOs: 8, 16, 37, 47, 71, 79, 98, 106, 112, 119, 133 and 141; (v) a V_L CDR2 sequence selected from the group consisting of SEQ ID NOs: 9, 38, 48, 58, 72, 80, 89, 99, 113, 120 and 142; and (vi) a V_L CDR3 sequence selected from the group consisting of SEQ ID NOs: 10, 24, 29, 39, 49, 59, 73, 81, 90, 100, 107, 114, 121, 126 and 143.

In one embodiment, the huIP-10 antibodies of the invention include a variable heavy chain region comprising the amino acid sequence of SEQ ID NO:2 and a light chain variable region comprising the amino acid sequence of SEQ ID NO:4.

The huIP-10 antibodies of the invention include a V_H CDR1 region comprising the amino acid sequence of SEQ ID NO: 5, a V_H CDR2 region comprising the amino acid sequence of SEQ ID NO:6; and a V_H CDR3 region comprising the amino acid sequence of SEQ ID NO:7. The huIP-10 antibodies include a V_L CDR1 region comprising the amino acid sequence of SEQ ID NO: 8; a V_L CDR2 region comprising the amino acid sequence of SEQ ID NO:9; and a V_L CDR3 region comprising the amino acid sequence of SEQ ID NO: 10. In a preferred embodiment, the huIP-10 antibody includes a V_H CDR1 region comprising the amino acid sequence of SEQ ID NO: 5, a V_H CDR2 region comprising the amino acid sequence of SEQ ID NO:6; a V_H CDR3 region comprising the amino acid sequence of SEQ ID NO:7, a V_L CDR1 region comprising the amino acid sequence of SEQ ID NO: 8; a V_L CDR2 region comprising the amino acid sequence of SEQ ID NO:9; and a V_L CDR3 region comprising the amino acid sequence of SEQ ID NO: 10.

Preferably, the huIP-10 antibodies are formatted in an IgG isotype. More preferably, the huIP-10 antibodies are formatted in an IgG1 isotype. An exemplary IgG1-formatted antibody is the IgG1-formatted NI-0801 antibody comprising the heavy chain sequence of SEQ ID NO: 135 and the light chain sequence of SEQ ID NO: 134, as shown below:

>NI-0801 Light Chain Amino Acid Sequence
NFMLTQPHSVSESPGKTVTISCTGSGGSIASNYVQWYQQRPGSSPTTVIYEDNQRPSPGVPDR (SEQ ID NO: 134)

FSGSIDSSNSASLTISGLKTEDEADYQCQSYDPLPVVWVFGGGTKLTVLGQPKAAPSVTLFPP

PSSEELQANKATLVCLISDFYPGAVTVAWKADSSPVKAGVETTTPSKQSNKKAASSYLSLT

PEQWKSHRSYSCQVTHEGSTVEKTVAPTECS

>NI-0801 Heavy Chain Amino Acid Sequence
QVQLVESGGGVVQPGRSLRLSCAASGFTFSNSGIHWVRQAPGKLEWVAVISYDGSNKYYAD (SEQ ID NO: 135)

- continued

SVKGRFTISRDNKNTLYLQMNLSRAEDTAVYYCARLRDNAEYTDYWGQGLVTVSSASTKG
 PSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQSSGLYSLSS
 VVTVPSSSLGTQTYICNVNHKPSNTKVDKRVKPKSCDKTHTCPCCPAPELLGGPSVFLFPPK
 PKDTLMISRTPEVTCVVVDVSHEDPEVKFNWYVDGVEVHNAKTKPREEQYNSTYRVVSVLTV
 LHQDWLNGKEYKCKVSNKALPAPIEKTISKAKGQPREPQVYTLPPSREEMTKNQVSLTCLVK
 GFYPSDIAVEWESNGQPENNYKTPPVLDSDGSFFLYSLKLTVDKSRWQQGNVFSVCSVMHEAL
 HNHYTQKSLSLSPGK

The closest germline for the huIP-10 antibodies described herein are shown below in Table 1:

TABLE 1

Closest germlines for the huIP-10 antibodies.		
Clone ID	VH dp number	VL dp number
NI-0801	Vh3_DP-49_(3-30.5)	Vlambda6_6a
CF1N1R3P4_C7	Vh3_DP-49_(3-30.5)	Vlambda6_6a
CF1H1R3P3_G11	Vh3_DP-49_(3-30.5)	Vlambda6_6a
CF1A11R3P3_F3	Vh3_DP-49_(3-30.5)	Vlambda6_6a
CF1H1R3P4_B5	Vh3_DP-49_(3-30.5)	Vlambda6_6a
CC21R3P1_F1	Vh3_DP-49_(3-30.5)	Vlambda6_6a
CC21R3P1_B9	Vh3_DP-49_(3-30.5)	Vlambda3_DPL16_(3l)
CB21R3P3_E5	Vh3_DP-49_(3-30.5)	Vlambda6_6a
CC21R3P1_H6	Vh3_DP-49_(3-30.5)	Vlambda3_3h
CC21R3P5_C5	Vh3_DP-49_(3-30.5)	Vlambda3_3j
CB1R3P4_D3	Vh3_DP-49_(3-30.5)	Vlambda3_DPL16_(3l)
CB2R2P4_C3	Vh2_DP-27, 28_(2-70)	Vlambda1_DPL2_(1c)
CC21R3P4_F4	Vh3_DP-49_(3-30.5)	Vlambda3_3h
CC21R3P1_C1a	Vh3_DP-49_(3-30.5)	Vlambda3_3h
CC21R3P3_C1	Vh3_DP-49_(3-30.5)	Vlambda3_3h
CC21R3P1_E7	Vh3_DP-49_(3-30.5)	Vlambda1_DPL2_(1c)
CE7C1R3H8_J9	Vh3_DP-49_(3-30.5)	Vlambda1_DPL2_(1c)
CB21R3P1_F1	Vh3_DP-49_(3-30.5)	Vlambda3_DPL16_(3l)
CC21R3P1_A2	Vh3_DP-86_(3-66)	Vlambda1_DPL2_(1c)
CB21R3P6_G7	Vh1_DP-10_(1-69)	Vlambda1_DPL2_(1c)

In another aspect, the invention provides methods of treating, preventing or alleviating a symptom of an immune-related disorder by administering a huIP-10 antibody to a subject. For example, the huIP-10 antibodies are used to treat, prevent or alleviate a symptom associated with an autoimmune disease or inflammatory disorder. Optionally, the subject is further administered with a second agent such as, but not limited to, an anti-cytokine or anti-chemokine reagent that recognizes cytokines such as interleukin 1 (IL-1), IL-2, IL-4, IL-6, IL-12, IL-13, IL-15, IL-17, IL-18, IL-20, IL-21, IL-22, IL-23, IL-27 and IL-31, and/or chemokines such as MIP1 alpha, MIP1 beta, RANTES, MCP1, IP-10, ITAC, MIG, SDF and fractalkine.

The subject is suffering from or is predisposed to developing an immune related disorder, such as, for example, an autoimmune disease or an inflammatory disorder. Preferably, the subject is a mammal, and more preferably, the subject is a human.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1A-FIG. 3B are a series of graphs depicting the dose-dependent neutralizing activity of huIP-10 antibodies of the invention on hIP-10-induced calcium flux (FIGS. 1A-1B) or cell chemotaxis (FIG. 2A-2B).

FIGS. 2A-2B depict the dose-dependent neutralizing activity on recombinant hIP-10, and

FIGS. 3A-3B depict the dose-dependent neutralizing activity on native hIP-10.

FIG. 4 is a graph depicting the capacity of huIP-10 antibodies to bind hIP-10 in the context of glycosaminoglycan (GAG).

FIG. 5 is an illustration comparing the immunoglobulin heavy variable gene of antibody CF1N1R3P4_C7 and the human germ line DP-49 or IGHV3-30. The C7 VH has 5 mutations compared to IGHV3-30, three in the CDR1, one in CDR2 and one in the framework four. The C7 VL has 4 mutations compared to IGLV6-57, all located in the CDR1. The mutated amino acid residues are boxed in FIG. 5.

FIGS. 6A and 6B are graphs depicting the affinity of antibodies CC21R3P1_F1 and NI-0801 for hIP-10.

FIG. 7 is a graph depicting the cross-reactivity of the NI-0801 antibody with IP-10 from a variety of species and other human chemokines.

FIGS. 8A-8B are two graphs depicting the ability of recombinant hITAC, hMIG and hIP-10 to induce cells chemotaxis of hCXCR3 expressing L1.2 cells, and the ability of the NI-0801 antibody to neutralize the activity of these chemokines.

FIG. 9 is a graph depicting the neutralization potential of NI-0801 on IP-10 from a variety of different species.

FIG. 10 is an illustration depicting an alignment of the IP-10 protein sequences from several species.

FIG. 11 is a graph depicting the ability of the NI-0801 antibody to bind mutated versions of rabbit IP-10.

DETAILED DESCRIPTION

The present invention provides fully human monoclonal antibodies specific for interferon-inducible protein 10 (IP-10, CXCL10). The antibodies are collectively referred to herein as huIP-10 antibodies. The huIP-10 antibodies specifically bind IP-10. As used herein, the terms "specific for", "specific binding", "directed against" (and all grammatical variations thereof) are used interchangeably in the context of antibodies that recognize and bind to an IP-10 epitope when the equilibrium binding constant (K_d) is $\leq 1 \mu\text{M}$, e.g., $\leq 100 \text{ nM}$, preferably $\leq 10 \text{ nM}$, and more preferably $\leq 1 \text{ nM}$. For example, the huIP-10 antibodies provided herein exhibit a K_d in the range approximately between $\leq 200 \text{ pM}$ to about 1 pM .

The huIP-10 antibodies are, for example, IP-10 antagonists or inhibitors that modulate at least one biological activity of IP-10. Biological activities of IP-10 include, for example, binding the IP-10 receptor (CXCR3), IP-10 induced calcium flux, IP-10 induced cell chemotaxis, IP-10 binding to glycosaminoglycan, and IP-10 oligomerization. For example, the huIP-10 antibodies completely or partially inhibit IP-10 activity by partially or completely blocking the binding of IP-10 to the IP-10 receptor (CXCR3). The IP-10 antibodies

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are considered to completely inhibit IP-10 activity when the level of IP-10 activity in the presence of the huIP-10 antibody is decreased by at least 95%, e.g., by 96%, 97%, 98%, 99% or 100% as compared to the level of IP-10 activity in the absence of binding with a huIP-10 antibody described herein. The IP-10 antibodies are considered to partially inhibit IP-10 activity when the level of IP-10 activity in the presence of the huIP-10 antibody is decreased by less than 95%, e.g., 10%, 20%, 25%, 30%, 40%, 50%, 60%, 75%, 80%, 85% or 90% as compared to the level of IP-10 activity in the absence of binding with a huIP-10 antibody described herein.

The huIP-10 antibodies of the invention are produced by immunizing an animal with IP-10, such as, for example, murine or human IP-10 or an immunogenic fragment, derivative or variant thereof. Alternatively, the animal is immunized

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with cells transfected with a vector containing a nucleic acid molecule encoding IP-10, such that IP-10 is expressed and associated with the surface of the transfected cells. Alternatively, the antibodies are obtained by screening a library that contains antibody or antigen binding domain sequences for binding to IP-10. This library is prepared, e.g., in bacteriophage as protein or peptide fusions to a bacteriophage coat protein that is expressed on the surface of assembled phage particles and the encoding DNA sequences contained within the phage particles (i.e., "phage displayed library").

huIP-10 antibodies of the invention include, for example, the heavy chain complementarity determining regions (CDRs) shown below in Table 2, the light chain CDRs shown in Table 3, and combinations thereof.

TABLE 2

VH CDR sequences from antibody clones that bind and neutralize IP-10			
Clone ID	Heavy CDR1 (SEQ ID NO)	Heavy CDR2	Heavy CDR3
NI-0801	NSGIH... (SEQ ID 5)	VISY...DGSNKYYADSVK (SEQ NO 6)	LRDNAEYT...DY (SEQ NO 7)
CF1N1R3P4_C7	NSGIH... (SEQ ID 5)	VISY...DGSNKFYADSVK (SEQ NO 15)	LRDNAEYT...DY (SEQ NO 7)
CF1H1R3P3_G11	NSGIH... (SEQ ID 5)	VISY...DGSNKFYADSVK (SEQ NO 15)	LRDNGEYL...DY (SEQ NO 21)
CF1A11R3P3_F3	NSGIH... (SEQ ID 5)	VISY...DGSNKFYADSVK (SEQ NO 15)	LRDNGEYL...DY (SEQ NO 21)
CF1H1R3P4_B5	NSGIH... (SEQ ID 5)	VISY...DGSNKFYADSVK (SEQ NO 15)	LRDNGEYL...DY (SEQ NO 21)
CC21R3P1_F1	NSGIH... (SEQ ID 5)	VISY...DGSNKFYADSVK (SEQ NO 15)	DGSESEYL...DY (SEQ NO 132)
CC21R3P1_B9	SYGMH... (SEQ ID 34)	VISY...DGSNKYYADSVK (SEQ NO 6)	DGGWYDWYF...DL (SEQ NO 140)
CB21R3P3_E5	SYGMH... (SEQ NO 34)	VISY...DGSIKYYADSVK (SEQ NO 35)	APDGHQL...DY (SEQ NO 57)
CC21R3P1_H6	NYGMH... (SEQ NO 95)	VISY...DGSNRYADSVK (SEQ NO 96)	DAGGPL...DY (SEQ NO 97)
CC21R3P5_C5	TYGMH... (SEQ NO 86)	VISY...DGGTKYYADSVK (SEQ NO 87)	DLGDLPPGL...DY (SEQ NO 88)
CB1R3P4_D3	SYGMH... (SEQ NO 34)	VISY...DGSIKYYADSVK (SEQ NO 35)	AGYSTDWHP...DY (SEQ NO 36)
CB2R2P4_C3	TSGMSVI... (SEQ NO 44)	RID...SDDEKHYNTSLKT (SEQ NO 45)	LRAGSGPYVF...DS (SEQ NO 46)
CC21R3P4_F4	NYGMH... (SEQ NO 95)	VISY...DGSNRYADSVK (SEQ NO 96)	DAGGPL...DY (SEQ NO 97)
CC21R3P1_C1a	SYGMH... (SEQ NO 34)	VISY...DGSNKYYADSVK (SEQ NO 6)	DEFDAF...DI (SEQ NO 78)
CC21R3P3_C1	SYGMH... (SEQ NO 34)	VISY...DGSIKYYADSVK (SEQ NO 35)	DWGFSGSLTF...DY (SEQ NO 105)
CC21R3P1_E7	TYGMH... (SEQ NO 86)	VISY...DGGTKYYADSVK (SEQ NO 87)	DLGDLPPGL...DY (SEQ NO 88)
CE7C1R3H8_J9	TYGMH... (SEQ NO 87)	VISY...DGGTKYYADSVK (SEQ NO 87)	DLGDLPPGL...DY (SEQ NO 88)
CB21R3P1_F1	SYGMH... (SEQ NO 34)	VISY...DGSIKYYADSVK (SEQ NO 35)	VMGTDPHSYYYM...DV (SEQ NO 52)

TABLE 2-continued

VH CDR sequences from antibody clones that bind and neutralize IP-10			
Clone ID	Heavy CDR1 (SEQ ID NO)	Heavy CDR2	Heavy CDR3
CC21R3P1_A2	DTYMN... (SEQ NO 127)	SIY.....SDDSTYYADSVKG (SEQ NO 128)	DKEYVTSTGGAYYYFYM.....DV (SEQ NO 129)
CB21R3P6_G7	SFSIT... (SEQ NO 64)	EITP.....MFGIANYAQKFQG (SEQ NO 65)	DGRFDVSDLLTDKPKVTINYNGMDV (SEQ NO 66)

TABLE 3

VL CDR sequences from antibody clones that bind and neutralize IP-10			
Clone ID	Light CDR1	Light CDR2	Light CDR3
NI-0801	TGSGGS.....IASNYVQ (SEQ NO 8)	ED....NQRPS (SEQ NO 9)	QSYDPLPV.....WV (SEQ NO 10)
CF1N1R3P4_C7	TGSGGS.....IDRNYVQ (SEQ NO 16)	ED....NQRPS (SEQ NO 9)	QSYDPLPV.....WV (SEQ NO 10)
CF1H1R3P3_G11	TGSGGS.....IDRNYVQ (SEQ NO 16)	ED....NQRPS (SEQ NO 9)	QSYDPLPV.....WV (SEQ NO 10)
CF1A11R3P3_F3	TGSGGS.....IDRNYVQ (SEQ NO 16)	ED....NQRPS (SEQ NO 9)	QSYDSINL.....WV (SEQ NO 29)
CF1H1R3P4_B5	TGSGGS.....IDRNYVQ (SEQ NO 16)	ED....NQRPS (SEQ NO 9)	QSYVETPE.....WV (SEQ NO 24)
CC21R3P1_F1	TGSGGS.....IDRNYVQ (SEQ NO 16)	ED....NQRPS (SEQ NO 9)	QSYDSINL.....WV (SEQ NO 29)
CC21R3P1_B9	QGDS.....LTSYYAS (SEQ NO 141)	GN....DNRPS (SEQ NO 142)	GSRDSSGYQ.....VV (SEQ NO 143)
CB21R3P3_E5	TGSSGS.....IASNYVQ (SEQ NO 133)	ED....DQRPS (SEQ NO 58)	QSYVSSK.....WV (SEQ NO 59)
CC21R3P1_H6	GGDN.....IGRKSVMH (SEQ NO 98)	DD....TDRPS (SEQ NO 99)	QVWDSSIDHS.....WV (SEQ NO 100)
CC21R3P5_C5	GGSS.....IESKSVH (SEQ NO 119)	KD....SNRPS (SEQ NO 120)	QVWDSSTG.....VV (SEQ NO 121)
CB1R3P4_D3	QGDS.....LRSYYAS (SEQ NO 37)	GK....NNRPS (SEQ NO 38)	NSRDSSGNH.....VV (SEQ NO 39)
CB2R2P4_C3	SGSSSN.....IGSNTVMN (SEQ NO 47)	NN....DQRPS (SEQ NO 48)	ASWDDSLNG.....RV (SEQ NO 49)
CC21R3P4_F4	GGNN.....IGDKSVQ (SEQ NO 112)	DD....SDRPS (SEQ NO 113)	QVWDSSSDHPE.....VV (SEQ NO 114)
CC21R3P1_C1a	GGNN.....IGSRSMH (SEQ NO 79)	YD....SDRPS (SEQ NO 80)	QVWDTSSTG.....YV (SEQ NO 81)
CC21R3P3_C1	GGNN.....IGSKSVH (SEQ NO 106)	YD....SDRPS (SEQ NO 80)	QVWDSSSDH.....VV (SEQ NO 107)
CC21R3P1_E7	SGSSSN.....IGSNTVMN (SEQ NO 47)	TN....NQRPS (SEQ NO 89)	AAWDDSLNG.....VV (SEQ NO 90)
CE7C1R3H8_J9	SGSSSN.....IGSNTVMN (SEQ NO 47)	TN....NQRPS (SEQ NO 89)	AAWDDSEPR.....VV (SEQ NO 126)
CB21R3P1_F1	QGDS.....LRSYYAS (SEQ NO 37)	GK....NNRPS (SEQ NO 38)	NSRDSSGNH.....VL (SEQ NO 158)
CC21R3P1_A2	SGSSSN.....IGSDTMN (SEQ NO 71)	NN....NQRPS (SEQ NO 72)	AAWDDSLNG.....LV (SEQ NO 73)

TABLE 3-continued

VL CDR sequences from antibody clones that bind and neutralize IP-10			
Clone ID	Light CDR1	Light CDR2	Light CDR3
CB21R3P6_G7	SGSSSN.....IGSNTVN (SEQ NO 47)	NN.....DQRPS (SEQ NO 48)	ASWDDSLNG.....RV (SEQ NO 49)

An exemplary huIP-10 monoclonal antibody is the NI-0801 antibody described herein. As shown below, the NI-0801 antibody includes a heavy chain variable region (SEQ ID NO:2) encoded by the nucleic acid sequence shown in SEQ ID NO:1, and a light chain variable region (SEQ ID NO:3) encoded by the nucleic acid sequence shown in SEQ ID NO:4.

sequences: NSGIH (SEQ ID NO:5); VISYDGSNKFYADS-VKG (SEQ ID NO:15); and LRDNAEYTDY (SEQ ID NO:7). The light chain CDRs of the C7 antibody have the following sequences: TSGGGSIDRNYVQ (SEQ ID NO:16); EDNQRPS (SEQ ID NO:9); and QSYDPLPVWV (SEQ ID NO:10).

>NI-0801 VH nucleic acid sequence (SEQ ID NO: 1)
CAGGTGCAGCTGGTGGAGTCTGGGGGAGGCGTGGTCCAGCCTGGGAGGTCCCTGAGACTCTC

CTGTGCAGCCTCTGGATTACCTTCAGTAACTCTGGCATACTGGGTCCGCCAGGCTCCAG

GCAAGGGACTGGAGTGGGTGGCAGTTATATCATATGATGGAAGTAACAAATACTACGCAGAC

TCCGTGAAGGGCCGATTACCATCTCCAGAGACAACCTCCAAGAACACTCTGTATCTGCAAAT

GAACAGCCTGAGAGCTGAGGACACGGCTGTCTATTATTGTGCAAGATTGAGGGATAATGCGG

AGTATACTGATTACTGGGGCCAGGGAACCCTGGTCACCGTCTCGAGT

>NI-0801 VH amino acid sequence (SEQ ID NO: 2)
QVQLVESGGGVVQPGRSRLRLSCAASGFTFSNSGIHWVRQAPGKLEWVAVISYDGSNKYYAD

SVKGRFTISRDNKNTLYLQMNSLRRAEDTAVYYCARLRDNEEYTDYWGQGLVTVSS

>NI-0801 VL nucleic acid sequence (SEQ ID NO: 3)
AATTTTATGCTGACTCAGCCCACTCTGTGTCGGAGTCTCCGGGAAGACGGTAACCATCTC

CTGCACCGGCAGCGGTGGCAGCATTGCCAGCAACTATGTGCAGTGGTACCAACAGCGCCCGG

GCAGTTCCCCCACCCTGTCTATGAGGATAACCAGAGACCCTCTGGGGTCCCTGATCGG

TTCTCTGGCTCCATCGACAGCTCCTCCAATTCTGCCTCCCTCACCATCTCTGGGCTGAAGAC

TGAGGACGAGGCTGACTACTACTGTGAGTCTTATGATCCGCTTCCGGTGTGGGTTTTCGGCG

GAGGGACCAAGCTGACCGTCCTAG

>NI-0801 VL amino acid sequence (SEQ ID NO: 4)
NFMLTQPHSVSESPGKTVTISCTGSGGSIASNYVQWYQQRPGSSPTTVIYEDNQRPSGVPDR

FSGSIDSSNSASLTISGLKTEDEADYYCQSYDPLPVWVFGGGTKLTVL

The amino acids encompassing the complementarity determining regions (CDR) are as defined by Chothia et al. and E. A. Kabat et al. (See Chothia, C, et al., Nature 342:877-883 (1989); Kabat, E A, et al., Sequences of Protein of immunological interest, Fifth Edition, US Department of Health and Human Services, US Government Printing Office (1991)). The heavy chain CDRs of the C7 antibody have the following

An exemplary huIP-10 monoclonal antibody is the CF1N1R3P4_C7 ("C7") antibody described herein. As shown below, the C7 antibody includes a heavy chain variable region (SEQ ID NO:12) encoded by the nucleic acid sequence shown in SEQ ID NO:11, and a light chain variable region (SEQ ID NO:14) encoded by the nucleic acid sequence shown in SEQ ID NO:13.

>CF1N1R3P4_C7 VH nucleic acid sequence (SEQ ID NO: 11)
CAGGTGCAGCTGGTGGAGTCTGGGGGAGGCGTGGTCCAGCCTGGGAGGTCCCTGAGACTCTC

CTGTGCAGCCTCTGGATTACCTTCAGTAACTCTGGCATACTGGGTCCGCCAGGCTCCAG

GCAAGGGACTGGAGTGGGTGGCAGTTATATCATATGATGGAAGTAACAAATTCTACGCAGAC

TCCGTGAAGGGCCGATTACCATCTCCAGAGACAACCTCCAAGAACACTCTGTATCTGCAAAT

- continued

GAACAGCCTGAGAGCTGAGGACACGGCTGTCTATTATTGTGCAAATGAGGGATAATGCGG

AGTATACTGATTACTGGGGCCAGGGAACCCTGGTCACCGTCTCGAGTG

>CF1N1R3P4_C7 VH amino acid sequence

QVQLVESGGGVVQPGRSLRLSCAASGFTFSNSGIHWVRQAPGKLEWVAVISYDGSNKFYAD (SEQ ID NO: 12)

SVKGRFTISRDNKNTLYLQMNSLRAEDTAVYYCAKLRDNEAYTDYWGQGLVTVSS

>CF1N1R3P4_C7 VL nucleic acid sequence

AATTTTATGCTGACTCAGCCCCACTCTGTGTCGGAGTCTCCGGGAAGACGGTGACCATCTC (SEQ ID NO: 13)

CTGCACCGGCAGCGGTGGCAGCATTGACAGAACTATGTGCAGTGGTACCAGCAGCGCCCGG

GCAGTTCACCCACTGTGATCTATGAGGATAACCAAAGACCCTCTGGGGTCCCGGATCGA

TTCTCTGGCTCCATCGACAGCTCCTCCAACCTGCCTCCCTCACCATCTCTGGACTAAAAAC

TGAAGACGAGGCTGACTACTACTGTGAGTCTTATGATCCGCTTCCGGTGTGGGTTTTTCGGCG

GAGGGACCAAGCTCACCGTCCTA

>CF1N1R3P4_C7 VL amino acid sequence

NFMLTQPHSVSESPGKTVTISCTGSGGSIDRNYVQWYQRPSSPTTVIYEDNQRPSGVPDR (SEQ ID NO: 14)

FSGSIDSSNSASLTISGLKTEDEADYQCQSYDPLPVWVFGGGTKLTVL

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The amino acids encompassing the complementarity determining regions (CDR) are as defined by Chothia et al. and E. A. Kabat et al. (See Chothia, C, et al., Nature 342:877-883 (1989); Kabat, E A, et al., Sequences of Protein of immunological interest, Fifth Edition, US Department of Health and Human Services, US Government Printing Office (1991)). The heavy chain CDRs of the C7 antibody have the following sequences: NSGIH (SEQ ID NO:5); VISYDGSNKFYADSVKG (SEQ ID NO:15); and LRDNEAYTDY (SEQ ID NO:7). The light chain CDRs of the C7 antibody have the following sequences: TSGGGSIDSNYVQ (SEQ ID NO:16);

EDNQRPS (SEQ ID NO:9); and QSYDPLPVWV (SEQ ID NO:10).

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An exemplary huIP-10 monoclonal antibody is the CF1H1R3P3_G11 ("G11") antibody described herein. As shown below, the G11 antibody includes a heavy chain variable region (SEQ ID NO:17) encoded by the nucleic acid sequence shown in SEQ ID NO:17, and a light chain variable region (SEQ ID NO:14) encoded by the nucleic acid sequence shown in SEQ ID NO:19.

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>CF1H1R3P3_G11 VH nucleic acid sequence

CAGGTGCAGCTGGTGGAGTCTGGGGGAGGCGTGGTCCAGCCTGGGAGGTCCCTGAGACTCTC (SEQ ID NO: 17)

CTGTGCAGCCTCTGGATTCACCTTCAGTAACTCTGGCATACTGGGTCCGCCAGGCTCCAG

GCAAGGGACTGGAGTGGGTGGCAGTTATATCATATGATGGAAGTAACAAATTCTACGCAGAC

TCCGTGAAGGGCCGATTACCATCTCCAGAGACAACTCCAAGAACAATCTGTATCTGCAAAT

GAACAGCCTGAGAGCTGAGGACACGGCTGTCTATTATTGTGCAAATGAGGGATAATGGTG

AGTACTTAGACTACTGGGGCCAGGGAACCCTGGTCACCGTCTCGAGT

>CF1H1R3P3_G11 VH amino acid sequence

QVQLVESGGGVVQPGRSLRLSCAASGFTFSNSGIHWVRQAPGKLEWVAVISYDGSNKFYAD (SEQ ID NO: 18)

SVKGRFTISRDNKNTLYLQMNSLPAEDTAVYYCAKLRDNGEYLDYWGQGLVTVSS

>CF1H1R3P3_G11 VL nucleic acid sequence

AATTTTATGCTGACTCAGCCCCACTCTGTGTCGGAGTCTCCGGGAAGACGGTGACCATCTC (SEQ ID NO: 19)

CTGCACCGGCAGCGGTGGCAGCATTGACAGAACTATGTGCAGTGGTACCAGCAGCGCCCGG

GCAGTTCACCCACTGTGATCTATGAGGATAACCAAAGACCCTCTGGGGTCCCGGATCGA

TTCTCTGGCTCCATCGACAGCTCCTCCAACCTGCCTCCCTCACCATCTCTGGACTAAAAAC

TGAAGACGAGGCTGACTACTACTGTGAGTCTTATGATCCGCTTCCGGTGTGGGTTTTTCGGCG

GAGGGACCAAGCTCACCGTCCTA

-continued

>CF1H1R3P3_G11 VL amino acid sequence
 NFMLTQPHSVSESPGKTVTISCTGSGGSIDRNYVQWYQQRPGSSPTTVIYEDNQRPSPGVDR (SEQ ID NO: 14)
 FSGSIDSSNSASLTISGLKTEDEADYQCQSYDPLPVWVFGGGTKLTVL

The amino acids encompassing the complementarity determining regions (CDR) are as defined by Chothia et al. and E. A. Kabat et al. (See Chothia, C, et al., Nature 342:877-883 (1989); Kabat, E A, et al., Sequences of Protein of immunological interest, Fifth Edition, US Department of Health and Human Services, US Government Printing Office (1991)). The heavy chain CDRs of the G11 antibody have the following sequences: NSGIH (SEQ ID NO:5); VISYDGSNKFY-ADSVKG (SEQ ID NO:15); and LRDNGEYLDY (SEQ ID NO:21). The light chain CDRs of the G11 antibody have the following sequences: TSGGGSIDRNYVQ (SEQ ID NO:16); EDNQRP (SEQ ID NO:9); and QSYDPLPVWV (SEQ ID NO:10).

An exemplary huIP-10 monoclonal antibody is the CF1H1R3P4_B5 ("B5") antibody described herein. As shown below, the B5 antibody includes a heavy chain variable region (SEQ ID NO:18) encoded by the nucleic acid sequence shown in SEQ ID NO:17, and a light chain variable region (SEQ ID NO:22) encoded by the nucleic acid sequence shown in SEQ ID NO:23.

>CF1H1R3P4_B5 VH nucleic acid sequence
 CAGGTGCAGCTGGTGGAGTCTGGGGGAGGCGTGGTCCAGCCTGGGAGGTCCCTGAGACTCTC (SEQ ID NO: 17)
 CTGTGCAGCCTCTGGATTACCTTCAGTAACTCTGGCATACTGGGTCCGCCAGGCTCCAG
 GCAAGGGACTGGAGTGGGTGGCAGTTATATCATATGATGGAAGTAACAAATTCACGCAGAC
 TCCGTGAAGGGCCGATTACCATCTCCAGAGACAACTCCAAGAACAATCTGTATCTGCAAAT
 GAACAGCCTGAGAGCTGAGGACACGGCTGTCTATTATTGTGCAAATGAGGGATAATGGTG
 AGTACTTAGACTACTGGGGCCAGGGAACCCTGGTCACCGTCTCGAGT

>CF1H1R3P4_B5 VH amino acid sequence
 QVQLVESGGGVVQPGRSLRLSCAASGFTFSNSGIHWVRQAPGKGLEWVAVISYDGSNKFYAD (SEQ ID NO: 18)
 SVKGRFTISRDNKNTLYLQMNSLRAEDTAVYYCAKLRDNGEYLDYWGQGLTVTVSS

>CF1H1R3P4_B5 VL nucleic acid sequence
 AATTTTATGCTGACTCAGCCCACTCTGTGTGGAGTCTCCGGGAAGACGGTGACCATCTC (SEQ ID NO: 22)
 CTGCACCGGCAGCGGTGGCAGCATTGACAGAACTATGTGCAGTGGTACCAGCAGCGCCCGG
 GCAGTTCACCCACTGTGATCTATGAGGATAACCAAAGACCCTCTGGGTCCCGGATCGA
 TTCTCTGGCTCCATCGACAGCTCCTCCAATCTGCCTCCCTCACCATCTCTGGACTAAAAAC
 TGAAGACGAGGCTGACTACTACTGTGAGTCTTATGTGGAGACGCTGAGTGGGTTTTTCGGCG
 GAGGGACCAAGCTCACCGTCCCTAG

>CF1H1R3P4_B5 VL amino acid sequence
 NFMLTQPHSVSESPGKTVTISCTGSGGSIDRNYVQWYQQRPGSSPTTVIYEDNQRPSPGVDR (SEQ ID NO: 23)
 FSGSIDSSNSASLTISGLKTEDEADYQCQSYVETPEWVFGGGTKLTVL

The amino acids encompassing the complementarity determining regions (CDR) are as defined by Chothia et al. and E. A. Kabat et al. (See Chothia, C, et al., Nature 342:877-883 (1989); Kabat, E A, et al., Sequences of Protein of immunological interest, Fifth Edition, US Department of Health and Human Services, US Government Printing Office (1991)). The heavy chain CDRs of the B5 antibody have the following sequences: NSGIH (SEQ ID NO:5); VISYDGSNKFYADSVKG (SEQ ID NO:15); and LRDNGEYLDY (SEQ ID NO:21). The light chain CDRs of the B5 antibody have the following sequences: TSGGGSIDRNYVQ (SEQ ID NO:16); EDNQRP (SEQ ID NO:9); and QSYVETPEWV (SEQ ID NO:24).

An exemplary huIP-10 monoclonal antibody is the CF1A11R3P3_F3 ("F3") antibody described herein. As shown below, the F3 antibody includes a heavy chain variable region (SEQ ID NO:18) encoded by the nucleic acid sequence shown in SEQ ID NO:17, and a light chain variable region (SEQ ID NO:28) encoded by the nucleic acid sequence shown in SEQ ID NO:27.

>CF1A11R3P3_F3 VH nucleic acid sequence
 CAGGTGCAGCTGGTGGAGTCTGGGGGAGGCGTGGTCCAGCCTGGGAGGTCCCTGAGACTCTC (SEQ ID NO: 17)
 CTGTGCAGCCTCTGGATTACCTTCAGTAACTCTGGCATACTGGGTCCGCCAGGCTCCAG
 GCAAGGGACTGGAGTGGGTGGCAGTTATATCATATGATGGAAGTAACAAATTCTACGCAGAC
 TCCGTGAAGGGCCGATTACCATCTCCAGAGACAACTCCAAGAACACTCTGTATCTGCAAAT
 GAACAGCCTGAGAGCTGAGGACACGGCTGTCTATTATTGTGCAAAATTGAGGGATAATGGTG
 AGTACTTAGACTACTGGGGCCAGGGAACCCTGGTCCCGTCTCGAGT

>CF1A11R3P3_F3 VH amino acid sequence
 QVQLVESGGGVVQPGRSLRLS CAASGFTFSNSGIHWVRQAPGKLEWVAVISYDGSNKFYAD (SEQ ID NO: 18)
 SVKGRFTISRDN SKNTLYLQMNSLRAEDTAVYYCAKLRDNGEYLDYWGQGLVTVSS

>CF1A11R3P3_F3 VL nucleic acid sequence
 AATTTTATGCTGACTCAGCCCACTCTGTGTCTGGAGTCTCCGGGAAGACGGTGACCATCTC (SEQ ID NO: 27)
 CTGCACCGGCAGCGGTGGCAGCATTGACAGAACTATGTGCAGTGGTACCAGCAGCGCCCGG
 GCAGTGCCCCCATCACTGTGATCTATGAGGATAACCAAAGACCCTCTGGGGTCCCGGATCGA
 TTCTCTGGCTCCATCGACAGCTCTCCAACCTGCCTCCCTACCATCTCTGGACTACGGAC
 TGACGACGAGGCTGACTACTACTGTGAGTCTTATGATAGCATCAATCTTTGGGTTTTCGGCG
 GAGGGACCAAGGTCACCGTCTTAGG

>CF1A11R3P3_F3 VL amino acid sequence
 NFMLTQPHSVSESPGKTVTISCTGSGGSIDRNYVQWYQRPGSAPITVIYEDNQRPSGVPDR (SEQ ID NO: 28)
 FSGSIDSSNSASLTISGLRTDDEADYQCYSYDSINLWVFGGGTKVTVL

The amino acids encompassing the complementarity determining regions (CDR) are as defined by Chothia et al. and E. A. Kabat et al. (See Chothia, C, et al., Nature 342:877-883 (1989); Kabat, E A, et al., Sequences of Protein of immunological interest, Fifth Edition, US Department of Health and Human Services, US Government Printing Office (1991)). The heavy chain CDRs of the F3 antibody have the following sequences: NSGIH (SEQ ID NO:5); VISYDGSNKFYADSVK (SEQ ID NO:15); and LRDNGEYLDY (SEQ ID NO:21). The light chain CDRs of the F3 antibody have the following sequences: TSGSGSIDRNYVQ (SEQ ID

NO:16); EDNQRPS (SEQ ID NO:9); and QSYDSINLWV (SEQ ID NO:29).

An exemplary huP-10 monoclonal antibody is the CB1R3P4_D3 ("D3") antibody described herein. As shown below, the D3 antibody includes a heavy chain variable region (SEQ ID NO:31) encoded by the nucleic acid sequence shown in SEQ ID NO:30, and a light chain variable region (SEQ ID NO:33) encoded by the nucleic acid sequence shown in SEQ ID NO:32.

>CB1R3P4_D3 VH nucleic acid sequence
 CAGGTGCAGCTGGTGCAGTTTGGGGGAGGCGTGGTCCAGCCTGGGAGGTCCCTGAGACTCTC (SEQ ID NO: 30)
 CTGTGCAGCCTCTGGATTACCTTCAGTAGCTATGGCATGCACCTGGGTCCGCCAGGCTCCAG
 GCAAGGGGCTGGAGTGGGTGGCAGTTATATCATATGATGGAAGTATTAATACTATGCAGAC
 TCCGTGAAGGGCCGATTACCATCTCCAGAGAAAATGCCAAGAACTCCGTGTATCTGCAAAT
 GGACAGCCTGAGAGTCGGGGACACGGCTGTGTATTACTGTACAAGAGCCGGGTATAGTACTG
 ACTGGCATCCCGACTACTGGGGCCAGGGGACAATGGTCCCGTCTCGAGT

>CB1R3P4_D3 VH amino acid sequence
 QVQLVQFGGGVVQPGRSLRLS CAASGFTFSSYGMHWVRQAPGKLEWVAVISYDGSIKYYAD (SEQ ID NO: 31)
 SVKGRFTISRDN SKNTLYLQMNSLRAEDTAVYYCTRAGYSTDWHPDYWGQGLVTVSS

>CB1R3P4_D3 VL nucleic acid sequence
 TCTTCTGAGCTGACTCAGGACCCTGCTGTGTCTGTGGCCTGGGACAGACAGTCAGGATCAC (SEQ ID NO: 32)
 ATGCCAAGGAGACAGCCTCAGAAGCTATTATGCAAGCTGGTACCAGCAGAAGCCAGGACAGG

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GTDPHSYYYMDVWGKGLVTVSS
 >CB21R3P1_F1 VL nucleic acid sequence (SEQ ID NO: 144)
 TCTTCTGAGCTGACTCAGGACCTGCTGTGTCTGTGGCCTTGGGACAGAC
 AGTCAGGATCACATGCCAAGGAGACAGCCTCAGAAGCTATTATGCAAGCT
 GGTACCAGCGGAAGCCAGGACAGGCCCTGTACTTGTCTATCTATGGTAAA
 AACAAACCGGCCCTCAGGGATCCAGACCGATTCTCTGGCTCCAGCTCAGG
 AACACAGCTTCTTGACCATCACTGGGGCTCAGCGGAAGATGAGGCTG
 ACTATTACTGTAACTCCCGGACAGCAGTGGTAACCATGTGCTTTTCGGC
 GGAGGGACCAAGCTGACCGTCCTA
 >CB21R3P1_F1 VL amino acid sequence (SEQ ID NO: 145)
 SSELTDQPAVSVALGQTVRITCQDLSRYSYASWYQRKPGQAPVLVIYGK
 NNRPSGIPDRFSGSSSNTASLTITGAQAEDEADYYCNSRDSSGNHVLFG
 GGTKLTVL

The amino acids encompassing the complementarity determining regions (CDR) are as defined by Chothia et al. and E. A. Kabat et al. (See Chothia, C, et al., Nature 342:877-883 (1989); Kabat, E A, et al., Sequences of Protein of immunological interest, Fifth Edition, US Department of Health and Human Services, US Government Printing Office (1991)). The heavy chain CDRs of the CB_F1 antibody have the following sequences: SYGMH (SEQ ID NO:34); VISYDGSIKYY-ADSVK (SEQ ID NO:35); and VMGTDPH-SYYYMDV (SEQ ID NO:52). The light chain CDRs of the CB_F1 antibody have the following sequences: QGDSL-RSYYAS (SEQ ID NO:37); GKNNRPS (SEQ ID NO:38); and NSRDSSGNHVL (SEQ ID NO:39).

An exemplary huIP-10 monoclonal antibody is the CB21R3P3_E5 ("E5") antibody described herein. As shown below, the E5 antibody includes a heavy chain variable region (SEQ ID NO:54) encoded by the nucleic acid sequence shown in SEQ ID NO:53, and a light chain variable region (SEQ ID NO:56) encoded by the nucleic acid sequence shown in SEQ ID NO:55.

>CB21R3P3_E5 VH nucleic acid sequence (SEQ ID NO: 53)
 CAGGTGCAGCTGGTGGAGTCTGGGGAGGCGTGGTCCAGCCTGGGAGGTC
 CCTGAGACTCTCCTGTGCAGCCTCTGGATTACCTTCAGTAGCTATGGCA
 TGCACTGGGTCCGCCAGGCTCCAGGCAAGGGGCTGGAGTGGGTGGCAGTT
 ATATCATATGATGGAAGTATTAATACTATGCAGACTCCGTGAAGGGCCG
 ATTCACCATCTCCAGAGACAATTCCAAGAACACGCTGTATCTGCAAATGA
 ACAGCCTGAGAGCTGAGGACGCGGCTGTGTATTACTGTGCGAGAGACCA
 GATGGCCACCAACTTGACTACTGGGGCAGGGGCACCCTGGTCAACCGTCTC
 GAGT
 >CB21R3P3_E5 VH amino acid sequence (SEQ ID NO: 54)
 QVQLVESGGGVVQPGRLRLSCAASGFTFSSYGMHWVRQAPGKLEWVAV
 ISYDGSIKYYADSVKGRFTISRDNKNTLYLQMNLSRAEDAAYVYCARAP
 DGHQLDYWGRGTLVTVSS

-continued

>CB21R3P3_E5 VL nucleic acid sequence (SEQ ID NO: 55)
 AATTTTATGCTGACTCAGCCCCACTCTGTGTGCGGAGTCTCCGGGAAGAC
 5 GGTAACCATCTCCTGCACCGGCAGCAGTGGCAGCATTGCCAGCAACTATG
 TGCAGTGGTACCAGCAGCGCCCGGGCAGTGCCCCACCCTGTGATCTAT
 GAAGATGACCAAAGACCCTCTGACGTCCCTGATCGCTTCTCTGGCTCCAT
 10 CGACAGCTCCTCAACTCTGCCTCCCTCACCATCTCTGGACTGAGGACTG
 AGGACGAGGCTGACTACTACTGTCTTATGTTAGCAGCAAGTGGGTG
 TTCGGCGGAGGGACCAAGCTGACCGTCCTA
 15 >CB21R3P3_E5 VL amino acid sequence (SEQ ID NO: 56)
 NFMLTQPHSVSESPGKTVTISCTGSSGSIASNYVQWYQQRPGSAPTTVIY
 EDDQRPSDVPDRFSGSIDSSNSASLTISGLRTEDEADYYCQSYVSSKWV
 20 FGGGTKLTVL

The amino acids encompassing the complementarity determining regions (CDR) are as defined by Chothia et al. and E. A. Kabat et al. (See Chothia, C, et al., Nature 342:877-883 (1989); Kabat, E A, et al., Sequences of Protein of immunological interest, Fifth Edition, US Department of Health and Human Services, US Government Printing Office (1991)). The heavy chain CDRs of the E5 antibody have the following sequences: SYGMH (SEQ ID NO:34); VISYDGSIKYY-ADSVK (SEQ ID NO:35); and APDGHQLDY (SEQ ID NO:57). The light chain CDRs of the E5 antibody have the following sequences: TGSSGSIASNYVQ (SEQ ID NO:133); EDDQRPS (SEQ ID NO:58); and QSYVSSKWV (SEQ ID NO:59).

An exemplary huIP-10 monoclonal antibody is the CB21R3P6_G7 ("G7") antibody described herein. As shown below, the G7 antibody includes a heavy chain variable region (SEQ ID NO:61) encoded by the nucleic acid sequence shown in SEQ ID NO:60, and a light chain variable region (SEQ ID NO:63) encoded by the nucleic acid sequence shown in SEQ ID NO:62.

>CB21R3P6_G7 VH nucleic acid sequence (SEQ ID NO: 60)
 CAGGTGCAGCTGGTGCAGTCTGGGGCTGAGGTGAAGAAGCCTGGGTCCCTC
 GGTGACGGTCTCCTGCAAGGCTCTGGAGGCACCTTCAGCAGCTTTTCTA
 TCACCTGGCTGCGACAGGCCCTGGACAAGGGCTTGAGTGGATGGGAGAG
 50 ATCACCCCTATGTTTGGTATAGCAAACCTACGCACAGAAGTTCAGGGTAG
 GGTCACGATTAGCGCGGACGAGTCCACGAGCACAGCCTACATGGAGTTGA
 GTGGCTGACATCTGAAGACACGGCCATGTATTATTGTGCGAGAGATGGT
 55 CGGTTTGATGTTTCCGATCTTTTACTGACAAACCCAAAGTAACGATAAA
 CTACAACGGGATGGACGTCTGGGGCCAAGGCACCCTGGTCAACCGTCTCGA
 GT
 60 >CB21R3P6_G7 VH amino acid sequence (SEQ ID NO: 61)
 QVQLVQSGAEVKKPGSSVTVSCKASGGTFSSFSITWLRQAPGQLEWMGE
 ITPMFGIANYAQKFKQGRVTISADESTSTAYMELSLTSEDAMYYCARDG
 65 RFDVSDLLTDKPKVTINYNMGMDVWGQGLVTVSS

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>CB21R3P6_G7 VL nucleic acid sequence
(SEQ ID NO: 62)
CAGTCTGTGCTGACTCAGCCACCCTCAGCGTCTGGGACCCCGGGCAGAG
GGTCACCATCTCTTGTCTGGAAGCAGCTCCAACATCGGGAGTAACACTG
TAAACTGGTACCAGCGACTCCCAGGAGCGGCCCCCAACTCCTCATCTAC
AATAATGACCAGCGGCCCTCAGGGATCCCTGACCGATTCTCTGGCTCCAA
GTCTGGCACCTCAGGCTCCCTGGTCATCAGTGGGCTCCAGTCTGAAGATG
AGGCTGATTACTACTGTGCGTCATGGGATGACAGTCTGAATGGTCGGGTG
TTCGGCGGAGGGACCAAGCTGACCGTCCTA
>CB21R3P6_G7 VL amino acid sequence
(SEQ ID NO: 63)
QSVLTQPPSASGTPGQRVTSISCSGSSSNIGSNTVNWYQRLPGAAPQLLIY
NNDQRPSGIPDRFSGSKSGTSGSLVISGLQSEDEADYYCASWDDSLNGRV
FGGGTKLTVL

The amino acids encompassing the complementarity determining regions (CDR) are as defined by Chothia et al. and E. A. Kabat et al. (See Chothia, C, et al., Nature 342:877-883 (1989); Kabat, E A, et al., Sequences of Protein of immunological interest, Fifth Edition, US Department of Health and Human Services, US Government Printing Office (1991)). The heavy chain CDRs of the G7 antibody have the following sequences: SFSIT (SEQ ID NO:64); EITPMFGIANYAQK-FQG (SEQ ID NO:65); and DGRFDVSDLLTDKP-KVTINYNGMDV (SEQ ID NO:66). The light chain CDRs of the G7 antibody have the following sequences: SGSSS-NIGSNTVN (SEQ ID NO:47); NNDQRPS (SEQ ID NO:48); and ASWDDSLNGRV (SEQ ID NO:49).

An exemplary huIP-10 monoclonal antibody is the CC21R3P1_A2 ("A2") antibody described herein. As shown below, the A2 antibody includes a heavy chain variable region (SEQ ID NO:68) encoded by the nucleic acid sequence shown in SEQ ID NO:67, and a light chain variable region (SEQ ID NO:70) encoded by the nucleic acid sequence shown in SEQ ID NO:69.

>CC21R3P1_A2 VH nucleic acid sequence
(SEQ ID NO: 67)
CAGCTGGTGGAGTCTGGAGGAGGCTTGATCCAGCCTGGGGGTCCCTGAG
ACTTTCCTGTGCAGCCTCTGGATTCAGCGTCAAGTACACTGAACT
GGGTCCGCCAGGCTCCAGGGAAGGGCCTGGAGTGGGTGTCAAGTATTTAT
AGCGATGATAGCACATACTACGCAGACTCCGTGAAGGGCAGATTCACCAT
CTCCAGAGACAATTCCAAGAACACGCTGTTTCTTCAAATAAACAGTTTGA
GAGCCGAGGACACGGCTGTCTATTACTGTGCGAGAGATAAGGAGTATGTA
ACATCAACTGGGGGCGCCTACTACTACTTCTACTACATGGACGTCTGGGG
CCAGGGCACCCCTGGTCACCGTCTCGAGT
>CC21R3P1_A2 VH amino acid sequence
(SEQ ID NO: 68)
QLVESGGGLIQPGSLRLSCAASGFSVSDTYMNVWRQAPGKLEWVSSIY
SDDSTYYADSVKGRFTISRDNKNTLFLQINSRAEDTAVYYCARDKEYV
TSTGGAYYYFYMDVWGQTLVTVSS
>CC21R3P1_A2 VL nucleic acid sequence
(SEQ ID NO: 69)

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CAGTCTGTGCTGACTCAGCCACCCTCAGCGTCTGGGACCCCGGGCAGAG
AGTCTCCATCTCTGTTCTGGAAGCAGCTCCAACATCGGAAGTGATACTG
5 TGAAGTGGTACCAGCACCTCCCAGGAACGGCCCCAAACTCCTCATCTAT
AATAATAATCAGCGGCCCTCAGGGGTCCCTGACCGATTCTCTGGCTCCAA
GTCTGGCACCTCAGCCTCCCTGGCCATCAGTGGGCTCCAGTCTGAGGATG
10 AGGCTGATTATTACTGTGCCGATGGGATGACAGCCTGAATGGTCTGGTA
TTCGGCGGAGGGACCAAGGTACCGTCCTA
>CC21R3P1_A2 VL amino acid sequence
(SEQ ID NO: 70)
QSVLTQPPSASGTPGQRVTSISCSGSSSNIGSDTVNWYQHLPGTAPKLLIY
NNNQRPSTGVPDRFSGSKSGTSASLAISGLQSEDEADYYCAAWDDSLNGLV
FGGGTKVTVL

The amino acids encompassing the complementarity determining regions (CDR) are as defined by Chothia et al. and E. A. Kabat et al. (See Chothia, C, et al., Nature 342:877-883 (1989); Kabat, E A, et al., Sequences of Protein of immunological interest, Fifth Edition, US Department of Health and Human Services, US Government Printing Office (1991)). The heavy chain CDRs of the A2 antibody have the following sequences: DTYMN (SEQ ID NO:127); SIYSDDSTYY-ADSVK (SEQ ID NO:128); and DKEYVTSTGGAYYY-FYYMDV (SEQ ID NO:129). The light chain CDRs of the A2 antibody have the following sequences: SGSSSNIGS-DTVN (SEQ ID NO:71); NNNQRPS (SEQ ID NO:72); and AAWDDSLNGLV (SEQ ID NO:73).

An exemplary huIP-10 monoclonal antibody is the CC21R3P1_C1A ("C1a") antibody described herein. As shown below, the C1a antibody includes a heavy chain variable region (SEQ ID NO:75) encoded by the nucleic acid sequence shown in SEQ ID NO:74, and a light chain variable region (SEQ ID NO:77) encoded by the nucleic acid sequence shown in SEQ ID NO:76.

>CC21R3P1_C1A VH nucleic acid sequence
(SEQ ID NO: 74)
CAGGTGCAGCTGGTGGAGTCTGGGGAGGCGTGGTCCAGCCTGGGAGGTC
45 CCTGAGACTCTCTGTGCAGCCTCTGGATTCACCTTCAGTAGCTATGGCA
TGCAGTGGGTCGCCAGGCTCCAGGCAAGGGGCTGGAGTGGGTGGCAGTT
ATATCATATGATGGAAGTAATAAATACTATGCAGACTCCGTGAAGGGCCG
50 ATTCACCATCTCCAGAGACAATTCCAAGAACACGCTGTATCTGCAAATGA
ACAGCCTGAGAGCTGAGGACACGGCTGTGTATTACTGTGCGAAAGACGAG
TTTGATGCTTTTGATATCTGGGGCCGAGGGACAATGGTCACCGTCTCGA
55 GT
>CC21R3P1_C1A VH amino acid sequence
(SEQ ID NO: 75)
QVQLVESGGGVVQPGSLRLSCAASGFTFSSYGMHWVRQAPGKLEWVAV
60 ISYDGSNKYYADSVKGRFTISRDNKNTLYLQMNLSRAEDTAVYYCAKDE
FDAFDIWRGTMVTVSS
>CC21R3P1_C1A VL nucleic acid sequence
(SEQ ID NO: 76)
65 TCCTATGTGCTGACTCAGCCCCCTCAGTGTGGTGGCCCCAGGAACGAC

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GGCCAGGATTACCTGTGGGGGAAACAATATCGGAAGTAGGAGTGTGCATT
 GGTACCAGCAGAAGCCAGGCCAGGCCCCCTCTACTGGTCATCTATTATGAT
 AGTGACCGGCCCTCAGGGATCCCTCTGCGATTCTCTGGCTCCAACCTCTGG
 AACACGGCCACCCTGACCATCAGTAGGGTGAAGCCGGGGATGAGGCCG
 ACTATTACTGTGAGGTGTGGGATACTAGTAGTGGTCATTATGTCTTCGGA
 ACTGGGACCAAGGTCACCGTCCTA
 >CC21R3P1_C1A VL amino acid sequence
 (SEQ ID NO: 77)
 SYVLTQPPSVSVAPGTTARITCGGNNIGSRVSHWYQQKPGQAPLLVIYYD
 SDRPSGIPLRFSGSNSGNTATLTISRVEAGDEADYQCQVWDTSSGHYVFG
 TGTKVTVL

The amino acids encompassing the complementarity determining regions (CDR) are as defined by Chothia et al. and E. A. Kabat et al. (See Chothia, C, et al., Nature 342:877-883 (1989); Kabat, E A, et al., Sequences of Protein of immunological interest, Fifth Edition, US Department of Health and Human Services, US Government Printing Office (1991)). The heavy chain CDRs of the C1a antibody have the following sequences: SYGMH (SEQ ID NO:34); VISYDG-SNKYYADSVKG (SEQ ID NO:6); and DEFDAFDI (SEQ ID NO:78). The light chain CDRs of the C1a antibody have the following sequences: GGNNIGSRVSH (SEQ ID NO:79); YSDRPS (SEQ ID NO:80); and QVWDTSS-GHYV (SEQ ID NO:81).

An exemplary huIP-10 monoclonal antibody is the CC21R3P3_C1 ("C1") antibody described herein. As shown below, the C1 antibody includes a heavy chain variable region (SEQ ID NO:102) encoded by the nucleic acid sequence shown in SEQ ID NO:101, and a light chain variable region (SEQ ID NO:104) encoded by the nucleic acid sequence shown in SEQ ID NO:103.

>CC21R3P3_C1 VH nucleic acid sequence
 (SEQ ID NO: 101)
 CAGGTGCAGCTGGTGGAGTCTGGGGGAGGCGTGGTCCAGCCTGGGAGGTC
 CCTGAGACTCTCTGTGCAGCCTCTGGATTACCTTCAGTAGCTATGGCA
 TGCACTGGGTCCGCCAGGCTCCAGGCAAGGGGCTGGAGTGGGTGGCAGTT
 ATATCATATGATGGAAGTATTAATACTATGCAGACTCCGTGAAGGGCCG
 ATTCACCATCTCCAGAGACAATTCCAGGAACACGCTGTATCTGCAGATGA
 ACAGCCTGAGACCTGAGGACACGGCTGTTTATTACTGTGCGAAAGATTGG
 GGATTTAGCGGCTCCCTAACATTTGATTATTGGGGCCAAGGGACAATGGT
 CACCGTCTCGAGT
 >CC21R3P3_C1 VH amino acid sequence
 (SEQ ID NO: 102)
 QVQLVESGGGVVQPGRSRLRLSCAASGFTFSSYGMHWVRQAPGKLEWVAV
 ISYDGSIKYYADSVKGRFTISRDNRSNTLYLQMNSLRPEDTAVYYCAKDW
 GFSGLTFDYWGQGMVTVSS
 >CC21R3P3_C1 VL nucleic acid sequence
 (SEQ ID NO: 103)
 TCCTATGTGCTGACTCAGCCACCCTCAGTGTGAGTGGCCCCAGGAAAGAC
 GGCCAGGATTACCTGTGGGGGAAACAACATTGGAAGTAAAAGTGTGCACT

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GGTACCAGCAGAAGCCAGGCCAGGCCCTGTGCTGGTCATCTATTATGAT
 AGCGACCGGCCCTCAGGGATCCCTGAGCGATTCTCTGGCTCCAACCTCTGG
 GAACACGGCCACCCTGACCATCAGCAGGGTGAAGCCGGGGATGAGGCCG
 ACTATTACTGTGAGGTGTGGGATAGTAGTAGTATCATGTGGTATTCGGC
 GGAGGGACCAAGGTCACCGTCCTA
 >CC21R3P3_C1 VL amino acid sequence
 (SEQ ID NO: 104)
 SYVLTQPPSVSVAPGKTARITCGGNNIGSKSVHWYQQKPGQAPVLIYYD
 SDRPSGIPERFSGSNSGNTATLTISRVEAGDEADYQCQVWDTSSDHVVFV
 GGTKVTVL

The amino acids encompassing the complementarity determining regions (CDR) are as defined by Chothia et al. and E. A. Kabat et al. (See Chothia, C, et al., Nature 342:877-883 (1989); Kabat, E A, et al., Sequences of Protein of immunological interest, Fifth Edition, US Department of Health and Human Services, US Government Printing Office (1991)). The heavy chain CDRs of the C1 antibody have the following sequences: SYGMH (SEQ ID NO:34); VISYDGSIKYY-ADSVKG (SEQ ID NO:35); and DWGFSGLTFDY (SEQ ID NO:105). The light chain CDRs of the C1 antibody have the following sequences: GGNNIGSKSVH (SEQ ID NO:106); YSDRPS (SEQ ID NO:80); and QVWDTSS-DHVV (SEQ ID NO:107).

An exemplary huIP-10 monoclonal antibody is the CC21R3P1_E7 ("E7") antibody described herein. As shown below, the E7 antibody includes a heavy chain variable region (SEQ ID NO:83) encoded by the nucleic acid sequence shown in SEQ ID NO:82, and a light chain variable region (SEQ ID NO:85) encoded by the nucleic acid sequence shown in SEQ ID NO:84.

>CC21R3P1_E7 VH nucleic acid sequence
 (SEQ ID NO: 82)
 CAGCTGGTGGAGTCTGGGGGAGGCGTGGTCCAGCCTGGGAGGTCCTGAG
 ACTCTCCTGTGCAGCCTCTGGATTACCTTCAGTACCTATGGCATGCACT
 GGGTCCGCCAGGCTCCAGGCAAGGGGCTGGAGTGGGTGGCAGTTATATCA
 TATGATGGAGGTACTAAATACTATGCAGACTCCGTGAAGGGCCGATTAC
 CATCTCCAGAGACAATTCCATGAAAACGCTCTATCTGCAAATGAACAGCC
 TGAGAAGTGAAGACACGGCTGTGTATTACTGTGCGAAAGATCTGGGGGAC
 CTACCCCCGGGCTTACTACTGGGGCCAGGGGACAATGGTCACCGTCTC
 GAGT
 >CC21R3P1_E7 VH amino acid sequence
 (SEQ ID NO: 83)
 QLVESGGGVVQPGRSRLRLSCAASGFTFSTYGMHWVRQAPGKLEWVAVIS
 YDGGTKYYADSVKGRFTISRDNMKTLYLQMNSLRTEDEAVYYCAKDLGD
 LPPGLDYWGQGMVTVSS
 >CC21R3P1_E7 VL nucleic acid sequence
 (SEQ ID NO: 84)
 CAGTCTGTGCTGACTCAGCCACCCTCAGCGTCTGGGACCCCGGGCAGAG
 GGTCACCATCTCTTGTCTGGAAGCAGCTCCAACATCGGAAGTAATACTG
 TAAACTGGTACCAGCAGCTCCAGGAGCGGCCCCAACTCCTCATCTAT

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ACTAATAATCAGCGGCCCTCAGGGGTCCTGACCGATTCTCTGGCTCCAA
 GTCTGGCACCTCAGCCTCCCTGGCCATCAGTGGGCTCCAGTCTGAGGATG
 AGGCTGATTATTACTGTGCAGCATGGGATGACAGCCTGAATGGTAATGTG
 GTATTTCGGCGGAGGGACCAAGGTCACCGTCCTA
 >CC21R3P1_E7 VL amino acid sequence (SEQ ID NO: 85)
 QSVLTQPPSASGTPGQRTVITISCSGSSNIGSNTVNWYQQLPGAAPKLLIY
 TNNQRPSGVPDRFSGSKSGTSASLAISGLQSEDEADYYCAAWDDSLNGNV
 VFGGGTKVTVL

The amino acids encompassing the complementarity determining regions (CDR) are as defined by Chothia et al. and E. A. Kabat et al. (See Chothia, C, et al., Nature 342:877-883 (1989); Kabat, E A, et al., Sequences of Protein of immunological interest, Fifth Edition, US Department of Health and Human Services, US Government Printing Office (1991)). The heavy chain CDRs of the E7 antibody have the following sequences: TYGMH (SEQ ID NO:86); VISYDGGTKYY-ADSVKG (SEQ ID NO:87); and DLGDLPPGLDY (SEQ ID NO:88). The light chain CDRs of the E7 antibody have the following sequences: SGSSNIGSNTVN (SEQ ID NO:47); TNNQRPS (SEQ ID NO:89); and AAWDDSLNGNV (SEQ ID NO:90).

An exemplary huIP-10 monoclonal antibody is the CC21R3P1_H6 ("H6") antibody described herein. As shown below, the H6 antibody includes a heavy chain variable region (SEQ ID NO:92) encoded by the nucleic acid sequence shown in SEQ ID NO:91, and a light chain variable region (SEQ ID NO:94) encoded by the nucleic acid sequence shown in SEQ ID NO:93.

>CC21R3P1_H6 VH nucleic acid sequence (SEQ ID NO: 91)
 CAGGTGCAGCTGGTGGAGTCTGGGGGAGGCGTGGCTCAGTCTGGGAAGTC
 CCTGAGACTCTCCTGTGCAGCCTCTGGATTACCTTCAGTAACATATGGCA
 TGCACTGGGTCCGCCAGGCTCCAGGCAAGGGGCTGGAGTGGCTGGCAGTC
 ATATCATATGATGGAAGTAACAGATACTATGCAGACTCCGTGAAGGGCCG
 ATTCACCATCTCCAGAGACAATTCCAACAACACACTGAATCTGCAAATGA
 GCAGCCTGAGAGCTGAGGACACGGCTCTATATTACTGTGCGAAAGATGCC
 GGGGGCCGCTTGATTACTGGGGCAAGGGCACCTGGTCACCGTCTCGA
 GT
 >CC21R3P1_H6 VH amino acid sequence (SEQ ID NO: 92)
 QVQLVESGGVAQSGKSLRLSCAASGFTFSNYGMHWVRQAPGKLEWLAV
 ISYDGSNRYADSVKGRFTISRDNSTLNLQMSLRAEDTALYYCAKDA
 GGPLDYWGKGLTVTVSS
 >CC21R3P1_H6 VL nucleic acid sequence (SEQ ID NO: 93)
 CAGTCTGTGCTGACTCAGCTGACTCAGCCACCCTCGGTGCTACTGGCCCC
 AGGACAGACGGCCACCATTACTTGTGGGGGAGACAACATTGGACGTAAAA
 GTGTGCACTGGTACCAGCAGAAGCCAGGCCAGGCCCTGTGTTGGTCGTC
 TATGATGACACCGACCGCCCTCAGGGATCCCTGAGCGATTCTCTGGCTC

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CAACTCTGGGAACACGGCCACCCTAACCATCAGCAGGGTGAAGCCGGGG
 ATGAGGCCGACTATTACTGTGAGGTGTGGGATAGTAGTATTGATCATTTCT
 TGGGTGTTTCGGCGGAGGGACCAAGCTGACCGTCTAG
 >CC21R3P1_H6 VL amino acid sequence (SEQ ID NO: 94)
 QSVLTQLTQPPSVSLAPGQTATITCGGDNIGRKSVMHWYQKPGQAPVLVV
 YDDTDRPSGIPERFSGSNSGNTATLTISRVEAGDEADYYCQVWDSIDHS
 WVFGGGTKLTVL

The amino acids encompassing the complementarity determining regions (CDR) are as defined by Chothia et al. and E. A. Kabat et al. (See Chothia, C, et al., Nature 342:877-883 (1989); Kabat, E A, et al., Sequences of Protein of immunological interest, Fifth Edition, US Department of Health and Human Services, US Government Printing Office (1991)). The heavy chain CDRs of the H6 antibody have the following sequences: NYGMH (SEQ ID NO:95); VISYDGSNRY-ADSVKG (SEQ ID NO:96); and DAGGPLDY (SEQ ID NO:97). The light chain CDRs of the H6 antibody have the following sequences: GGDNIGRKSVMH (SEQ ID NO:98); DDTDRPS (SEQ ID NO:99); and QVWDSIDHSWV (SEQ ID NO:100).

An exemplary huIP-10 monoclonal antibody is the CC21R3P4_F4 ("F4") antibody described herein. As shown below, the F4 antibody includes a heavy chain variable region (SEQ ID NO:109) encoded by the nucleic acid sequence shown in SEQ ID NO:108, and a light chain variable region (SEQ ID NO:111) encoded by the nucleic acid sequence shown in SEQ ID NO:110.

>CC21R3P4_F4 VH nucleic acid sequence (SEQ ID NO: 108)
 CAGGTGCAGCTGGTGGAGTCTGGGGGAGGCGTGGCTCACTCTGGGAAGTC
 CCTGAGACTCTCCTGTGCAGCCTCTGGATTACCTTCAGTAACATATGGCA
 TGCACTGGGTCCGCCAGGCTCCAGGCAAGGGGCTGGAGTGGCTGGCAGTC
 ATATCATATGATGGGAGTAATAGATACTATGCAGACTCCGTGAAGGGCCG
 ATTCACCATCTCCAGAGACAATTCCAACAACACGCTGAATCTGCAAATGA
 GCAGCCTGAGAGCTGAGGACACGGCTCTGTATTACTGTGCGAAAGATGCC
 GGGGGCCGCTTGATTACTGGGGCCGGGCACCCTGGTCACCGTCTCGA
 GT
 >CC21R3P4_F4 VH amino acid sequence (SEQ ID NO: 109)
 QVQLVESGGVAHSGKSLRLSCAASGFTFSNYGMHWVRQAPGKLEWLAV
 ISYDGSNRYADSVKGRFTISRDNSTLNLQMSLRAEDTALYYCAKDA
 GGPLDYWGRGLTVTVSS
 >CC21R3P4_F4 VL nucleic acid sequence (SEQ ID NO: 110)
 TCCTATGTGCTGACTCAGCCACCCTCGGTGCTCAGTGGCCCCAGGACAGAT
 GGCCAGAATTACCTGTGGGGGAAACAACATTGGAGATAAAAGTGTGCAAT
 GGTACCAGCAGAGGCCAGGCCAGGCCCTCTACTGGTCGTCATGATGAT
 AGCGACCGGCCCTCAGGGATCCCTGAGCGCTTCTCTGGCTCTACTCTAG
 GAACACGGCCACCCTGACCATCAGCAGGGTGAAGCCGGGGATGAGGCCG

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ACTATTACTGTCAGGTGTGGGATAGTAGTAGTATCCGGAGGTGGTT
 TTCGGCGGAGGGACCAAGCTGACCGTCCTA
 >CC21R3P4_F4 VL amino acid sequence
 (SEQ ID NO: 111)
 SYVLTQPPSVSVAPGQMARITCGGNNIGDKSVQWYQQRPGQAPLLVYDD
 SDRPSGIPERFSGSYSRNTATLTISRVEAGDEADYYCQVWDSSTGVVFGG
 FGGGTKLTVL

The amino acids encompassing the complementarity determining regions (CDR) are as defined by Chothia et al. and E. A. Kabat et al. (See Chothia, C, et al., Nature 342:877-883 (1989); Kabat, E A, et al., Sequences of Protein of immunological interest, Fifth Edition, US Department of Health and Human Services, US Government Printing Office (1991)). The heavy chain CDRs of the F4 antibody have the following sequences: NYGMH (SEQ ID NO:95); VISYDGSNRY-ADSVK (SEQ ID NO:96); and DAGGPLDY (SEQ ID NO:97). The light chain CDRs of the F4 antibody have the following sequences: GGNIGDKSVQ (SEQ ID NO:112); DDSRPS (SEQ ID NO:113); and QVWDSSTGVV (SEQ ID NO: 114).

An exemplary huIP-10 monoclonal antibody is the CC21R3P5_C5 ("C5") antibody described herein. As shown below, the C5 antibody includes a heavy chain variable region (SEQ ID NO:116) encoded by the nucleic acid sequence shown in SEQ ID NO:115, and a light chain variable region (SEQ ID NO:118) encoded by the nucleic acid sequence shown in SEQ ID NO:117.

>CC21R3P5_C5 VH nucleic acid sequence
 (SEQ ID NO: 115)
 CAGGTCCAGCTGGTGCAGTCTGGGGAGGCGTGGTCCAGCCTGGGAGGTC
 CCTGAGACTCTCCTGTGCAGCCTCTGGATTACCTTCAGTACCTATGGCA
 TGCACTGGGTCCGCCAGGCTCCAGGCAAGGGGCTGGAGTGGGTGGCAGTT
 ATATCATATGATGGAGGTAATACTATGCAGACTCCGTGAAGGGCCG
 ATTCACCATCTCCAGAGACAATTCCATGAAAACGCTCTATCTGCAAATGA
 ACAGCCTGAGAACTGAGGACACGGCTGTGTATTACTGTGCGAAAGATCTG
 GGGGACCTACCCCCGGGCTTGACTACTGGGGCCGAGGGACAATGGTCAC
 CGTCTCGAGT
 >CC21R3P5_C5 VH amino acid sequence
 (SEQ ID NO: 116)
 QVQLVQSGGGVVPGRSLRLSCAASGFTFSTYGMHWVRQAPGKLEWVAV
 ISYDGGTKYYADSVKGRFTISRDNMKTLYLQMNLRTEDTAVYYCAKDL
 GDLPPGLDYWGRGTMVTVSS
 >CC21R3P5_C5 VL nucleic acid sequence
 (SEQ ID NO: 117)
 TCCTATGAGCTGACTCAGCCACCCTCAGTGTGAGTGGCCCTGGGACAGAC
 GGCCACGATTACCTGTGGGGGAGCAGTATTGAGAGTAAAAGTGTACT
 GGTACCAGGAGAAGCCAGGCCAGGCCCTGTCTGGTTCATCTATAAAGAT
 TCCAACCGGCCCTCTGTGATCCCTGAGCGATTCTCTGGCTCCAACCTCGG
 GAACACGGCCACCCTGACCATCGGCAGAGCCCAAGCCGGGGATGAGGCTG
 ACTATTACTGTCAGGTGTGGGACAGCAGTACTGGTGTGGTATTTCGGCGGA

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GGGACCAAGCTGACCGTCCTA
 >CC21R3P5_C5 VL amino acid sequence
 (SEQ ID NO: 118)
 SYELTQPPSVSVALGQTATITCGSSIESKSVHWYQEKPGQAPVLVIYKD
 SNRPSVIPERFSGSNSGNTATLTIGRAQAGDEADYYCQVWDSSTGVVFGG
 GTKLTVL

The amino acids encompassing the complementarity determining regions (CDR) are as defined by Chothia et al. and E. A. Kabat et al. (See Chothia, C, et al., Nature 342:877-883 (1989); Kabat, E A, et al., Sequences of Protein of immunological interest, Fifth Edition, US Department of Health and Human Services, US Government Printing Office (1991)). The heavy chain CDRs of the C5 antibody have the following sequences: TYGMH (SEQ ID NO:86); VISYDGGTKYY-ADSVK (SEQ ID NO:87); and DLGDLPPGLDY (SEQ ID NO:88). The light chain CDRs of the C5 antibody have the following sequences: GGSSIESKSVH (SEQ ID NO:119); KDSNRPS (SEQ ID NO:120); and QVWDSSTGVV (SEQ ID NO:121).

An exemplary huIP-10 monoclonal antibody is the CE7C1R3H8_J9 ("J9") antibody described herein. As shown below, the J9 antibody includes a heavy chain variable region (SEQ ID NO:123) encoded by the nucleic acid sequence shown in SEQ ID NO:122, and a light chain variable region (SEQ ID NO:125) encoded by the nucleic acid sequence shown in SEQ ID NO:124.

>CE7C1R3H8_J9 VH nucleic acid sequence
 (SEQ ID NO: 122)
 CAGGTCCAGTTGGTGGAGTCTGGGGAGGCGTGGTCCAGCCTGGGAGGTC
 CCTGAGACTCTCCTGTGCAGCCTCTGGATTACCTTCAGTACCTATGGCA
 TGCACTGGGTCCGCCAGGCTCCAGGCAAGGGGCTGGAGTGGGTGGCAGTT
 ATATCATATGATGGAGGTAATACTATGCAGACTCCGTGAAGGGCCG
 ATTCACCATCTCCAGAGACAATTCCATGAAAACGCTCTATCTGCAAATGA
 ACAGCCTGAGAACTGAGGACACGGCTGTGTATTACTGTGCGAAAGATCTG
 GGGGACCTACCCCCGGGCTTGACTACTGGGGCCAGGGACAATGGTCAC
 CGTCTCGAGT
 >CE7C1R3H8_J9 VH amino acid sequence
 (SEQ ID NO: 123)
 QVQLVESGGGVVQGRSLRLSCAASGFTFSTYGMHWVRQAPGKLEWVAV
 ISYDGGTKYYADSVKGRFTISRDNMKTLYLQMNLRTEDTAVYYCAKDL
 GDLPPGLDYWQGTMTVTVSS
 >CE7C1R3H8_J9 VL nucleic acid sequence
 (SEQ ID NO: 124)
 CAGTCTGTGCTGACTCAGCCACCCTCAGCGTCTGGGACCCCCGGGACAG
 GGTCACCATCTCTTGTCTGGAAGCAGCTCCAACATCGGAAGTAATACTG
 TAACTGGTACCAGCAGCTCCAGGAGCGGCCCCAACTCCTCATCTAT
 ACTAATAATCAGCGGCCCTCAGGGGTCCCCGACCGATTCTCTGGCTCCAA
 GTCTGGCACCTCAGCCTCCCTGGCCATCAGTGGGCTCCAGTCTGAGGATG
 AGGCTGATTATTACTGTGCAGCATGGGATGACAGCTCGGAGCCTCGTGTG
 GTATTCCGGCGGAGGGACCAAGGTCACCGTCCTA

-continued

>CE7C1R3H8_J9 VL amino acid sequence
(SEQ ID NO: 125)
QSVLTQPPSASGTPGQRVTISCSGSSSNIGSNTVNWYQQLPGAAPKLLIY
TNNQRPSGVPDRFSGSKSGTSASLAISGLQSEDEADYYCAAWDDSSSEPRV
VFGGGTKVTVL

The amino acids encompassing the complementarity determining regions (CDR) are as defined by Chothia et al. and E. A. Kabat et al. (See Chothia, C, et al., Nature 342:877-883 (1989); Kabat, E A, et al., Sequences of Protein of immunological interest, Fifth Edition, US Department of Health and Human Services, US Government Printing Office (1991)). The heavy chain CDRs of the J9 antibody have the following sequences: TYGMH (SEQ ID NO:86); VISYDGGTKYY-ADSVKG (SEQ ID NO:87); and DLGDLPPGLDY (SEQ ID NO:88). The light chain CDRs of the J9 antibody have the following sequences: SGSSSNIGSNTVN (SEQ ID NO:47); TNNQRPS (SEQ ID NO:89); and AAWDDSSSEPRVV (SEQ ID NO:126).

An exemplary huIP-10 monoclonal antibody is the CC21R3P1_B9 ("B9") antibody described herein. As shown below, the B9 antibody includes a heavy chain variable region (SEQ ID NO:137) encoded by the nucleic acid sequence shown in SEQ ID NO:136, and a light chain variable region (SEQ ID NO:139) encoded by the nucleic acid sequence shown in SEQ ID NO:138.

>CC21R3P1_B9 VH nucleic acid sequence
(SEQ ID NO: 136)
GAGGTGCAGCTGGTGCAGTCTGGGGGAGGCGTGGTCCAGCCTGGGAGGTC
CCTGAGACTCTCCTGTGCAGCCTCTGGATTACCTTCAGTAGCTATGGCA
TGCACTGGGTCCGCCAGGCTCCAGGCAAGGGGCTGGAGTGGGTGGCAGTT
ATATCATATGATGGAAGTAATAAATACTATGCAGACTCCGTGAAGGGCCG
ATTCACCATCTCCAGAGACAATTCCAAGAACACGCTGTATCTGCAAATGA
ACAGCCTGAGAGCTGAGGACACGGCTGTGTATTACTGTGCGAAAGACGGT
GGCTGGTACGACTGGTACTTCGATCTCTGGGGCAGGGGAACCTGGTCAC
CGTCTCGAGT

>CC21R3P1_B9 VH amino acid sequence
(SEQ ID NO: 137)
EVQLVQSGGGVVPGRSLRLSCAASGFTFSSYGMHWVRQAPGKGLEWVAV
ISYDGSNKYYADSVKGRFTISRDNKNTLYLQMNSLRAEDTAVYYCAKDG
GWYDWFYFDLWGRGTLVTVSS

>CC21R3P1_B9 VL nucleic acid sequence
(SEQ ID NO: 138)
TCTTCTGAGCTGACTCAGGACCCTGATGTGTCCGTGGCCTTGGGACAGAC
AGTCAGGATCACATGCCAAGGAGACAGCCTCACCAGCTATTATGCAAGCT
GGTACCAGCAGAAGCCAGGACAGGCCCTGTACTTGTCTATCTCTGGTAAT
GACAACCGGCCCTCAGGGATCCAGACCGATTCTCTGGCTCCAACCTCAGG
AAACACAGCTTCCTTGACCATCACTGGGGCTCAGGCGGAAGATGCGGCTG
ACTATTACTGTGGCTCCCGGACAGCAGCGTTACCAAGTGGTGTTCGGC

-continued

GCAGGGACCAAGCTGACCGTCCTA
5 >CC21R3P1_B9 VL amino acid sequence
(SEQ ID NO: 139)
SSELTQDPDVSVVALGQTVRITCQGDSLTSYYASWYQOKPGQAPVLVISGN
DNRPSGIPDRFSGSNSGNTASLTITGAQAEDAADYYCGSRDSSGYQVVFV
10 AGTKLTVL

The amino acids encompassing the complementarity determining regions (CDR) are as defined by Chothia et al. and E. A. Kabat et al. (See Chothia, C, et al., Nature 342:877-883 (1989); Kabat, E A, et al., Sequences of Protein of immunological interest, Fifth Edition, US Department of Health and Human Services, US Government Printing Office (1991)). The heavy chain CDRs of the B9 antibody have the following sequences: SYGMH (SEQ ID NO:34); VISYDGSNKYY-ADSVKG (SEQ ID NO:6); and DGGWYDWYFDL (SEQ ID NO:140). The light chain CDRs of the B9 antibody have the following sequences: QGDSLTSYYAS (SEQ ID NO:141); GNDNRPS (SEQ ID NO:142); and GSRDSS-GYQVV (SEQ ID NO:143).

25 An exemplary huIP-10 monoclonal antibody is the CC21R3P1_F1 ("CC_F1") antibody described herein. As shown below, the CC_F1 antibody includes a heavy chain variable region (SEQ ID NO:26) encoded by the nucleic acid sequence shown in SEQ ID NO:25, and a light chain variable region (SEQ ID NO:28) encoded by the nucleic acid sequence shown in SEQ ID NO:27.

>CC21R3P1_F1 VH nucleic acid sequence
(SEQ ID NO: 25)
35 CAGGTGCAGCTGGTGGAGTCTGGGGGAGGCGTGGTCCAGCCTGGGAGGTC
CCACACACTCTCCTGTGCAGCCTCTGGATTTCGCTTCAAAAACCTCTGGCA
TACACTGGGTCCGCCAGGCTCCAGGCAAGGGACTGGAGTGGGTGGCAGTT
40 ATATCATATGATGGAAGTAACAAATTCTACGCAACTCCGTGAAGGGCCG
ATTCACCATCTCCAGAGACAACCTCCAGAACACTGTATATCTGCAAATGA
CTGACCTGAGACCTGACGACACGGCTGTCTATTATTGTGCAAGAGATGGG
45 AGTGAGAGCGAGTACTTAGACTACTGGGGCAAGGGAACCTGGTCACCGT
CTCGAGT

>CC21R3P1_F1 VH amino acid sequence
(SEQ ID NO: 26)
50 QVQLVESGGGVVQPGRSHTLSAASGFAPKNSGIHWVRQAPGKGLEWVAV
ISYDGSNKFYADSVKGRFTISRDNQNTVYLQMTDLRPDDTAVYYCARDG
SESEYLDYWGKGLVTVSS

55 >CC21R3P1_F1 VL nucleic acid sequence
(SEQ ID NO: 27)
AATTTTATGCTGACTCAGCCCCACTCTGTGTCCGAGTCTCCGGGAAGAC
GGTGACCATCTCCTGCACCGGCAGCGGTGGCAGCATTGACAGAACTATG
60 TGCAGTGGTACCAGCAGCGCCCGGCAGTGCCCCATCACTGTGATCTAT
GAGGATAACCAAAGACCCTCTGGGGTCCCGGATCGATTCTCTGGCTCCAT
CGACAGCTCCTCAACTCTGCCTCCCTCACCATCTCTGGACTACGGACTG
ACGACGAGGCTGACTACTACTGTCTAGTCTTATGATAGCATCAATCTTTGG
65 GTTTTCGGCGGAGGGACCAAGGTACCGTCCTAGG

-continued

>CC21R3P1_F1 VL amino acid sequence (SEQ ID NO: 28)
 NFMLTQPHSVSESPGKTVTISCTGSGGSIDRNYVQWYQQRPGSAPITVIY
 EDNQRPSGVPDRFSGSIDSSNSASLTISGLRTDDEADYYCQSYDSINLW
 VFGGGTKVTVL

The amino acids encompassing the complementarity determining regions (CDR) are as defined by Chothia et al. and E. A. Kabat et al. (See Chothia, C, et al., Nature 342:877-883 (1989); Kabat, E A, et al., Sequences of Protein of immunological interest, Fifth Edition, US Department of Health and Human Services, US Government Printing Office (1991)). The heavy chain CDRs of the CC_F1 antibody have the following sequences: NSGIH (SEQ ID NO:5); VISYDG-SNKFYADSVKVG (SEQ ID NO:15); and DGSESEYLDY (SEQ ID NO:132). The light chain CDRs of the CC_F1 antibody have the following sequences: TSGSGSIDRNYVQ (SEQ ID NO:16); EDNQRPS (SEQ ID NO:9); and QSYDSINLWV (SEQ ID NO:29).

huIP-10 antibodies of the invention also include antibodies that include a heavy chain variable amino acid sequence that is at least 90%, 92%, 95%, 97%, 98%, 99% or more identical the amino acid sequence of SEQ ID NO: 2, 12, 18, 26, 31, 41, 51, 54, 61, 68, 75, 83, 92, 102, 109, 116, 123 or 137 and/or a light chain variable amino acid that is at least 90%, 92%, 95%, 97%, 98%, 99% or more identical the amino acid sequence of SEQ ID NO: 4, 14, 23, 28, 33, 43, 56, 63, 70, 77, 85, 94, 104, 111, 118, 125, 139 or 145.

Alternatively, the monoclonal antibody is an antibody that binds to the same epitope as NI-0801, C7, G11, B5, F3, CC_F1, B9, E5, H6, C5, D3, C3, F4, C1a, C1, E7, J9, CB_F1, A2 and/or G7.

Unless otherwise defined, scientific and technical terms used in connection with the present invention shall have the meanings that are commonly understood by those of ordinary skill in the art. Further, unless otherwise required by context, singular terms shall include pluralities and plural terms shall include the singular. Generally, nomenclatures utilized in connection with, and techniques of, cell and tissue culture, molecular biology, and protein and oligo- or polynucleotide chemistry and hybridization described herein are those well known and commonly used in the art. Standard techniques are used for recombinant DNA, oligonucleotide synthesis, and tissue culture and transformation (e.g., electroporation, lipofection). Enzymatic reactions and purification techniques are performed according to manufacturer's specifications or as commonly accomplished in the art or as described herein. The foregoing techniques and procedures are generally performed according to conventional methods well known in the art and as described in various general and more specific references that are cited and discussed throughout the present specification. See e.g., Sambrook et al. Molecular Cloning: A Laboratory Manual (2d ed., Cold Spring Harbor Laboratory Press, Cold Spring Harbor, N.Y. (1989)). The nomenclatures utilized in connection with, and the laboratory procedures and techniques of, analytical chemistry, synthetic organic chemistry, and medicinal and pharmaceutical chemistry described herein are those well known and commonly used in the art. Standard techniques are used for chemical syntheses, chemical analyses, pharmaceutical preparation, formulation, and delivery, and treatment of patients.

As utilized in accordance with the present disclosure, the following terms, unless otherwise indicated, shall be understood to have the following meanings:

As used herein, the term "antibody" refers to immunoglobulin molecules and immunologically active portions of immunoglobulin (Ig) molecules, i.e., molecules that contain an antigen binding site that specifically binds (immunoreacts with) an antigen. Such antibodies include, but are not limited to, polyclonal, monoclonal, chimeric, single chain, F_{ab} , F_{ab} , and $F_{(ab)2}$ fragments, and an F_{ab} expression library. By "specifically bind" or "immunoreacts with" is meant that the antibody reacts with one or more antigenic determinants of the desired antigen and does not react (i.e., bind) with other polypeptides or binds at much lower affinity ($K_d > 10^{-6}$) with other polypeptides.

The basic antibody structural unit is known to comprise a tetramer. Each tetramer is composed of two identical pairs of polypeptide chains, each pair having one "light" (about 25 kDa) and one "heavy" chain (about 50-70 kDa). The amino-terminal portion of each chain includes a variable region of about 100 to 110 or more amino acids primarily responsible for antigen recognition. The carboxy-terminal portion of each chain defines a constant region primarily responsible for effector function. Human light chains are classified as kappa and lambda light chains. Heavy chains are classified as mu, delta, gamma, alpha, or epsilon, and define the antibody's isotype as IgM, IgD, IgA, IgG and IgE, respectively. Within light and heavy chains, the variable and constant regions are joined by a "J" region of about 12 or more amino acids, with the heavy chain also including a "D" region of about 10 more amino acids. See generally, Fundamental Immunology Ch. 7 (Paul, W., ea., 2nd ed. Raven Press, N.Y. (1989)). The variable regions of each light/heavy chain pair form the antibody binding site.

The term "monoclonal antibody" (MAb) or "monoclonal antibody composition", as used herein, refers to a population of antibody molecules that contain only one molecular species of antibody molecule consisting of a unique light chain gene product and a unique heavy chain gene product. In particular, the complementarity determining regions (CDRs) of the monoclonal antibody are identical in all the molecules of the population. MAbs contain an antigen binding site capable of immunoreacting with a particular epitope of the antigen characterized by a unique binding affinity for it.

In general, antibody molecules obtained from humans relate to any of the classes IgG, IgM, IgA, IgE and IgD, which differ from one another by the nature of the heavy chain present in the molecule. Certain classes have subclasses as well, such as IgG₁, IgG₂, and others. Furthermore, in humans, the light chain may be a kappa chain or a lambda chain.

The term "antigen-binding site," or "binding portion" refers to the part of the immunoglobulin molecule that participates in antigen binding. The antigen binding site is formed by amino acid residues of the N-terminal variable ("V") regions of the heavy ("H") and light ("L") chains. Three highly divergent stretches within the V regions of the heavy and light chains, referred to as "hypervariable regions," are interposed between more conserved flanking stretches known as "framework regions," or "FRs". Thus, the term "FR" refers to amino acid sequences which are naturally found between, and adjacent to, hypervariable regions in immunoglobulins. In an antibody molecule, the three hypervariable regions of a light chain and the three hypervariable regions of a heavy chain are disposed relative to each other in three dimensional space to form an antigen-binding surface. The antigen-binding surface is complementary to the three-dimensional surface of a bound antigen, and the three hypervariable regions of each of the heavy and light chains are referred to as "complementarity-determining regions," or "CDRs." The assignment of amino acids to each domain is in accordance

with the definitions of Kabat Sequences of Proteins of Immunological Interest (National Institutes of Health, Bethesda, Md. (1987 and 1991)), or Chothia & Lesk J. Mol. Biol. 196:901-917 (1987), Chothia et al. Nature 342:878-883 (1989).

As used herein, the term "epitope" includes any protein determinant capable of specific binding to an immunoglobulin, a scFv, or a T-cell receptor. The term "epitope" includes any protein determinant capable of specific binding to an immunoglobulin or T-cell receptor. Epitopic determinants usually consist of chemically active surface groupings of molecules such as amino acids or sugar side chains and usually have specific three dimensional structural characteristics, as well as specific charge characteristics. An antibody is said to specifically bind an antigen when the dissociation constant is $\leq 1 \mu\text{M}$; e.g., $\leq 100 \text{ nM}$, preferably $\leq 10 \text{ nM}$ and more preferably $\leq 200 \text{ pM}$.

As used herein, the terms "immunological binding," and "immunological binding properties" refer to the non-covalent interactions of the type which occur between an immunoglobulin molecule and an antigen for which the immunoglobulin is specific. The strength, or affinity of immunological binding interactions can be expressed in terms of the dissociation constant (K_d) of the interaction, wherein a smaller K_d represents a greater affinity. Immunological binding properties of selected polypeptides are quantified using methods well known in the art. One such method entails measuring the rates of antigen-binding site/antigen complex formation and dissociation, wherein those rates depend on the concentrations of the complex partners, the affinity of the interaction, and geometric parameters that equally influence the rate in both directions. Thus, both the "on rate constant" (K_{on}) and the "off rate constant" (K_{off}) can be determined by calculation of the concentrations and the actual rates of association and dissociation. (See Nature 361:186-87 (1993)). The ratio of K_{off}/K_{on} enables the cancellation of all parameters not related to affinity, and is equal to the dissociation constant K_d . (See, generally, Davies et al. (1990) Annual Rev Biochem 59:439-473). An antibody of the present invention is said to specifically bind to an IP-10 epitope when the equilibrium binding constant (K_d) is $\leq 1 \mu\text{M}$, e.g., $\leq 100 \text{ nM}$, preferably $\leq 10 \text{ nM}$, and more preferably $\leq 1 \text{ nM}$, as measured by assays such as radioligand binding assays or similar assays known to those skilled in the art. For example, the huIP-10 antibodies provided herein exhibit a K_d in the range approximately between $\leq 200 \text{ pM}$ to about 1 pM .

Those skilled in the art will recognize that it is possible to determine, without undue experimentation, if a human monoclonal antibody has the same specificity as a human monoclonal antibody of the invention (e.g., monoclonal antibody NI-0801, C7, G11, B5, F3, CB_F1, B9, E5, H6, C5, D3, C3, F4, C1a, C1, E7, J9, CC_F1, A1 or G7) by ascertaining whether the former prevents the latter from binding to a IP-10 antigen polypeptide. If the human monoclonal antibody being tested competes with a human monoclonal antibody of the invention, as shown by a decrease in binding by the human monoclonal antibody of the invention, then the two monoclonal antibodies bind to the same, or a closely related, epitope. Another way to determine whether a human monoclonal antibody has the specificity of a human monoclonal antibody of the invention is to pre-incubate the human monoclonal antibody of the invention with the IP-10 antigen polypeptide with which it is normally reactive, and then add the human monoclonal antibody being tested to determine if the human monoclonal antibody being tested is inhibited in its ability to bind the IP-10 antigen polypeptide. If the human monoclonal antibody being tested is inhibited then, in all

likelihood, it has the same, or functionally equivalent, epitopic specificity as the monoclonal antibody of the invention.

Various procedures known within the art are used for the production of the monoclonal antibodies directed against a protein such as an IP-10 protein, or against derivatives, fragments, analogs homologs or orthologs thereof. (See, e.g., Antibodies: A Laboratory Manual, Harlow E, and Lane D, 1988, Cold Spring Harbor Laboratory Press, Cold Spring Harbor, N.Y., incorporated herein by reference). Fully human antibodies are antibody molecules in which the entire sequence of both the light chain and the heavy chain, including the CDRs, arise from human genes. Such antibodies are termed "human antibodies", or "fully human antibodies" herein. Human monoclonal antibodies are prepared, for example, using the procedures described in the Examples provided below. Human monoclonal antibodies can be also prepared by using trioma technique; the human B-cell hybridoma technique (see Kozbor, et al., 1983 Immunol Today 4: 72); and the EBV hybridoma technique to produce human monoclonal antibodies (see Cole, et al., 1985 In: MONOCLONAL ANTIBODIES AND CANCER THERAPY, Alan R. Liss, Inc., pp. 77-96). Human monoclonal antibodies may be utilized and may be produced by using human hybridomas (see Cote, et al., 1983. Proc Natl Acad Sci USA 80: 2026-2030) or by transforming human B-cells with Epstein Barr Virus in vitro (see Cole, et al., 1985 In: MONOCLONAL ANTIBODIES AND CANCER THERAPY, Alan R. Liss, Inc., pp. 77-96).

Antibodies are purified by well-known techniques, such as affinity chromatography using protein A or protein G. Subsequently, or alternatively, the specific antigen which is the target of the immunoglobulin sought, or an epitope thereof, may be immobilized on a column to purify the immune specific antibody by immunoaffinity chromatography. Purification of immunoglobulins is discussed, for example, by D. Wilkinson (The Scientist, published by The Scientist, Inc., Philadelphia Pa., Vol. 14, No. 8 (Apr. 17, 2000), pp. 25-28).

It is desirable to modify the antibody of the invention with respect to effector function, so as to enhance, e.g., the effectiveness of the antibody in treating immune-related diseases. For example, cysteine residue(s) can be introduced into the Fc region, thereby allowing interchain disulfide bond formation in this region. The homodimeric antibody thus generated can have improved internalization capability and/or increased complement-mediated cell killing and antibody-dependent cellular cytotoxicity (ADCC). (See Caron et al., J. Exp Med., 176: 1191-1195 (1992) and Shopes, J. Immunol., 148: 2918-2922 (1992)). Alternatively, an antibody can be engineered that has dual Fc regions and can thereby have enhanced complement lysis and ADCC capabilities. (See Stevenson et al., Anti-Cancer Drug Design, 3: 219-230 (1989)).

The invention also includes F_v , F_{ab} , $F_{ab'}$ and $F_{(ab)2}$ huIP-10 fragments, single chain huIP-10 antibodies, bispecific huIP-10 antibodies and heteroconjugate huIP-10 antibodies.

Bispecific antibodies are antibodies that have binding specificities for at least two different antigens. In the present case, one of the binding specificities is for IP-10. The second binding target is any other antigen, and advantageously is a cell-surface protein or receptor or receptor subunit.

Methods for making bispecific antibodies are known in the art. Traditionally, the recombinant production of bispecific antibodies is based on the co-expression of two immunoglobulin heavy-chain/light-chain pairs, where the two heavy chains have different specificities (Milstein and Cuello, Nature, 305:537-539 (1983)). Because of the random assortment of immunoglobulin heavy and light chains, these hybridomas (quadromas) produce a potential mixture of ten differ-

ent antibody molecules, of which only one has the correct bispecific structure. The purification of the correct molecule is usually accomplished by affinity chromatography steps. Similar procedures are disclosed in WO 93/08829, published 13 May 1993, and in Trauneker et al., EMBO J., 10:3655-3659 (1991).

Antibody variable domains with the desired binding specificities (antibody-antigen combining sites) can be fused to immunoglobulin constant domain sequences. The fusion preferably is with an immunoglobulin heavy-chain constant domain, comprising at least part of the hinge, CH2, and CH3 regions. It is preferred to have the first heavy-chain constant region (CH1) containing the site necessary for light-chain binding present in at least one of the fusions. DNAs encoding the immunoglobulin heavy-chain fusions and, if desired, the immunoglobulin light chain, are inserted into separate expression vectors, and are co-transfected into a suitable host organism. For further details of generating bispecific antibodies see, for example, Suresh et al., Methods in Enzymology, 121:210 (1986).

Other approaches for generating bispecific antibodies are described, e.g., in WO 96/27011, which is hereby incorporated by reference in its entirety. Bispecific antibodies can be prepared as full length antibodies or antibody fragments (e.g. F(ab')₂ bispecific antibodies). Techniques for generating bispecific antibodies from antibody fragments have been described in the literature. For example, bispecific antibodies can be prepared using chemical linkage. See e.g., Brennan et al., Science 229:81 (1985), which is hereby incorporated by reference in its entirety.

Additionally, Fab' fragments can be directly recovered from *E. coli* and chemically coupled to form bispecific antibodies. See e.g., Shalaby et al., J. Exp. Med. 175:217-225 (1992), which is hereby incorporated by reference in its entirety.

Various techniques for making and isolating bispecific antibody fragments directly from recombinant cell culture have also been described. For example, bispecific antibodies have been produced using leucine zippers. See e.g., Kostelny et al., J. Immunol. 148 (5):1547-1553 (1992), which is hereby incorporated by reference in its entirety. The "diabody" technology described by Hollinger et al., Proc. Natl. Acad. Sci. USA 90:6444-6448 (1993), which is hereby incorporated by reference in its entirety, has provided an alternative mechanism for making bispecific antibody fragments. Another strategy for making bispecific antibody fragments by the use of single-chain Fv (sFv) dimers has also been reported. See, Gruber et al., J. Immunol. 152:5368 (1994), which is hereby incorporated by reference in its entirety.

Antibodies with more than two valencies are contemplated. For example, trispecific antibodies can be prepared. See, Tutt et al., J. Immunol. 147:60 (1991).

Exemplary bispecific antibodies can bind to two different epitopes, at least one of which originates in the protein antigen of the invention. Alternatively, an anti-antigenic arm of an immunoglobulin molecule can be combined with an arm which binds to a triggering molecule on a leukocyte such as a T-cell receptor molecule (e.g. CD2, IFN γ , CD28, or B7), or Fc receptors for IgG (Fc γ R), such as Fc γ RI (CD64), Fc γ RII (IFN γ 2) and Fc γ RIII (CD16) so as to focus cellular defense mechanisms to the cell expressing the particular antigen. Bispecific antibodies can also be used to direct cytotoxic agents to cells which express a particular antigen. These antibodies possess an antigen-binding arm and an arm which binds a cytotoxic agent or a radionuclide chelator, such as EOTUBE, DPTA, DOTA, or TETA. Another bispecific anti-

body of interest binds the protein antigen described herein and further binds tissue factor (TF).

Heteroconjugate antibodies are also within the scope of the present invention. Heteroconjugate antibodies are composed of two covalently joined antibodies. Such antibodies have, for example, been proposed to target immune system cells to unwanted cells (U.S. Pat. No. 4,676,980), and for treatment of HIV infection (WO 91/00360; WO 92/200373; EP 03089). It is contemplated that the antibodies can be prepared in vitro using known methods in synthetic protein chemistry, including those involving crosslinking agents. For example, immunotoxins can be constructed using a disulfide exchange reaction or by forming a thioether bond. Examples of suitable reagents for this purpose include iminothiolate and methyl-4-mercaptobutyrimidate and those disclosed, for example, in U.S. Pat. No. 4,676,980.

The invention also pertains to immunoconjugates comprising an antibody conjugated to a cytotoxic agent such as a toxin (e.g., an enzymatically active toxin of bacterial, fungal, plant, or animal origin, or fragments thereof), or a radioactive isotope (i.e., a radioconjugate).

Enzymatically active toxins and fragments thereof that can be used include diphtheria A chain, nonbinding active fragments of diphtheria toxin, exotoxin A chain (from *Pseudomonas aeruginosa*), ricin A chain, abrin A chain, modeccin A chain, alpha-sarcin, *Aleurites fordii* proteins, dianthin proteins, *Phytolaca americana* proteins (PAPI, PAPII, and PAPS), *momordica charantia* inhibitor, curcin, croton, sapaonaria officinalis inhibitor, gelonin, mitogellin, restrictocin, phenomycin, enomycin, and the tricothecenes. A variety of radionuclides are available for the production of radioconjugated antibodies. Examples include ²¹²Bi, ¹³¹I, ¹³¹In, ⁹⁰Y, and ¹⁸⁶Re.

Conjugates of the antibody and cytotoxic agent are made using a variety of bifunctional protein-coupling agents such as N-succinimidyl-3-(2-pyridyldithiol) propionate (SPDP), iminothiolane (IT), bifunctional derivatives of imidoesters (such as dimethyl adipimidate HCL), active esters (such as disuccinimidyl suberate), aldehydes (such as glutaraldehyde), bis-azido compounds (such as bis(p-azidobenzoyl) hexanediamine), bis-diazonium derivatives (such as bis-(p-diazoniumbenzoyl)-ethylenediamine), diisocyanates (such as tolyene 2,6-diisocyanate), and bis-active fluorine compounds (such as 1,5-difluoro-2,4-dinitrobenzene). For example, a ricin immunotoxin can be prepared as described in Vitetta et al., Science 238: 1098 (1987). Carbon-14-labeled 1-isothiocyanatobenzyl-3-methyldiethylene triaminepentaacetic acid (MX-DTPA) is an exemplary chelating agent for conjugation of radionuclide to the antibody. (See WO94/11026).

Those of ordinary skill in the art will recognize that a large variety of possible moieties can be coupled to the resultant antibodies or to other molecules of the invention. (See, for example, "Conjugate Vaccines", Contributions to Microbiology and Immunology, J. M. Cruse and R. E. Lewis, Jr (eds), Carger Press, New York, (1989), the entire contents of which are incorporated herein by reference).

Coupling is accomplished by any chemical reaction that will bind the two molecules so long as the antibody and the other moiety retain their respective activities. This linkage can include many chemical mechanisms, for instance covalent binding, affinity binding, intercalation, coordinate binding and complexation. The preferred binding is, however, covalent binding. Covalent binding is achieved either by direct condensation of existing side chains or by the incorporation of external bridging molecules. Many bivalent or polyvalent linking agents are useful in coupling protein mol-

ecules, such as the antibodies of the present invention, to other molecules. For example, representative coupling agents can include organic compounds such as thioesters, carbodiimides, succinimide esters, diisocyanates, glutaraldehyde, diazobenzenes and hexamethylene diamines. This listing is not intended to be exhaustive of the various classes of coupling agents known in the art but, rather, is exemplary of the more common coupling agents. (See Killen and Lindstrom, *Jour. Immun.* 133:1335-2549 (1984); Jansen et al., *Immunological Reviews* 62:185-216 (1982); and Vitetta et al., *Science* 238:1098 (1987). Preferred linkers are described in the literature. (See, for example, Ramakrishnan, S. et al., *Cancer Res.* 44:201-208 (1984) describing use of MBS (M-maleimido-benzoyl-N-hydroxysuccinimide ester). See also, U.S. Pat. No. 5,030,719, describing use of halogenated acetyl hydrazide derivative coupled to an antibody by way of an oligopeptide linker. Particularly preferred linkers include: (i) EDC (1-ethyl-3-(3-dimethylamino-propyl)carbodiimide hydrochloride; (ii) SMPT (4-succinimidyl-oxycarbonyl-alpha-methyl-alpha-(2-pyridyl-dithio)-toluene (Pierce Chem. Co., Cat. (21558G); (iii) SPDP (succinimidyl-6 [3-(2-pyridyl-dithio) propionamido]hexanoate (Pierce Chem. Co., Cat #21651 G); (iv) Sulfo-LC-SPDP (sulfosuccinimidyl 6 [3-(2-pyridyl-dithio)-propionamide]hexanoate (Pierce Chem. Co. Cat. #2165-G); and (v) sulfo-NHS(N-hydroxysulfo-succinimide: Pierce Chem. Co., Cat. #24510) conjugated to EDC.

The linkers described above contain components that have different attributes, thus leading to conjugates with differing physio-chemical properties. For example, sulfo-NHS esters of alkyl carboxylates are more stable than sulfo-NHS esters of aromatic carboxylates. NHS-ester containing linkers are less soluble than sulfo-NHS esters. Further, the linker SMPT contains a sterically hindered disulfide bond, and can form conjugates with increased stability. Disulfide linkages, are in general, less stable than other linkages because the disulfide linkage is cleaved in vitro, resulting in less conjugate available. Sulfo-NHS, in particular, can enhance the stability of carbodimide couplings. Carbodimide couplings (such as EDC) when used in conjunction with sulfo-NHS, forms esters that are more resistant to hydrolysis than the carbodimide coupling reaction alone.

The term "isolated polynucleotide" as used herein shall mean a polynucleotide of genomic, cDNA, or synthetic origin or some combination thereof, which by virtue of its origin the "isolated polynucleotide" (1) is not associated with all or a portion of a polynucleotide in which the "isolated polynucleotide" is found in nature, (2) is operably linked to a polynucleotide which it is not linked to in nature, or (3) does not occur in nature as part of a larger sequence.

The term "isolated protein" referred to herein means a protein of cDNA, recombinant RNA, or synthetic origin or some combination thereof, which by virtue of its origin, or source of derivation, the "isolated protein" (1) is not associated with proteins found in nature, (2) is free of other proteins from the same source, e.g., free of marine proteins, (3) is expressed by a cell from a different species, or (4) does not occur in nature.

The term "polypeptide" is used herein as a generic term to refer to native protein, fragments, or analogs of a polypeptide sequence. Hence, native protein fragments, and analogs are species of the polypeptide genus. Preferred polypeptides in accordance with the invention comprise the human heavy chain immunoglobulin molecules presented herein and the human light chain immunoglobulin molecules presented herein, as well as antibody molecules formed by combinations comprising the heavy chain immunoglobulin molecules with light chain immunoglobulin molecules, such as kappa

light chain immunoglobulin molecules, and vice versa, as well as fragments and analogs thereof.

The term "naturally-occurring" as used herein as applied to an object refers to the fact that an object can be found in nature. For example, a polypeptide or polynucleotide sequence that is present in an organism (including viruses) that can be isolated from a source in nature and which has not been intentionally modified by man in the laboratory or otherwise is naturally-occurring.

The term "operably linked" as used herein refers to positions of components so described are in a relationship permitting them to function in their intended manner. A control sequence "operably linked" to a coding sequence is ligated in such a way that expression of the coding sequence is achieved under conditions compatible with the control sequences.

The term "control sequence" as used herein refers to polynucleotide sequences which are necessary to effect the expression and processing of coding sequences to which they are ligated. The nature of such control sequences differs depending upon the host organism in prokaryotes, such control sequences generally include promoter, ribosomal binding site, and transcription termination sequence in eukaryotes, generally, such control sequences include promoters and transcription termination sequence. The term "control sequences" is intended to include, at a minimum, all components whose presence is essential for expression and processing, and can also include additional components whose presence is advantageous, for example, leader sequences and fusion partner sequences. The term "polynucleotide" as referred to herein means a polymeric chain of nucleotides of at least 10 bases in length, either ribonucleotides or deoxy-nucleotides or a modified form of either type of nucleotide. The term includes single and double stranded forms of DNA.

The term oligonucleotide referred to herein includes naturally occurring, and modified nucleotides linked together by naturally occurring, and non-naturally occurring oligonucleotide linkages. Oligonucleotides are a polynucleotide subset generally comprising a length of 200 bases or fewer. Preferably oligonucleotides are 10 to 60 bases in length and most preferably 12, 13, 14, 15, 16, 17, 18, 19, or 20 to 40 bases in length. Oligonucleotides are usually single stranded, e.g., for probes, although oligonucleotides may be double stranded, e.g., for use in the construction of a gene mutant. Oligonucleotides of the invention are either sense or antisense oligonucleotides.

The term "naturally occurring nucleotides" referred to herein includes deoxyribonucleotides and ribonucleotides. The term "modified nucleotides" referred to herein includes nucleotides with modified or substituted sugar groups and the like. The term "oligonucleotide linkages" referred to herein includes Oligonucleotide linkages such as phosphorothioate, phosphorodithioate, phosphoroselenoate, phosphorodiselenoate, phosphoroanilothioate, phosphoraniladate, phosphoronmidate, and the like. See e.g. LaPlanche et al. *Nucl. Acids Res.* 14:9081 (1986); Stec et al. *J. Am. Chem. Soc.* 106:6077 (1984), Stein et al. *Nucl. Acids Res.* 16:3209 (1988), Zon et al. *Anti Cancer Drug Design* 6:539 (1991); Zon et al. *Oligonucleotides and Analogues: A Practical Approach*, pp. 87-108 (F. Eckstein, Ed., Oxford University Press, Oxford England (1991)); Stec et al. U.S. Pat. No. 5,151,510; Uhlmann and Peyman *Chemical Reviews* 90:543 (1990). An oligonucleotide can include a label for detection, if desired.

The term "selectively hybridize" referred to herein means to detectably and specifically bind. Polynucleotides, oligonucleotides and fragments thereof in accordance with the invention selectively hybridize to nucleic acid strands under hybridization and wash conditions that minimize appreciable

amounts of detectable binding to nonspecific nucleic acids. High stringency conditions can be used to achieve selective hybridization conditions as known in the art and discussed herein. Generally, the nucleic acid sequence homology between the polynucleotides, oligonucleotides, and fragments of the invention and a nucleic acid sequence of interest will be at least 80%, and more typically with preferably increasing homologies of at least 85%, 90%, 95%, 99%, and 100%. Two amino acid sequences are homologous if there is a partial or complete identity between their sequences. For example, 85% homology means that 85% of the amino acids are identical when the two sequences are aligned for maximum matching. Gaps (in either of the two sequences being matched) are allowed in maximizing matching gap lengths of 5 or less are preferred with 2 or less being more preferred. Alternatively and preferably, two protein sequences (or polypeptide sequences derived from them of at least 30 amino acids in length) are homologous, as this term is used herein, if they have an alignment score of at more than 5 (in standard deviation units) using the program ALIGN with the mutation data matrix and a gap penalty of 6 or greater. See Dayhoff, M. O., in *Atlas of Protein Sequence and Structure*, pp. 101-110 (Volume 5, National Biomedical Research Foundation (1972)) and Supplement 2 to this volume, pp. 1-10. The two sequences or parts thereof are more preferably homologous if their amino acids are greater than or equal to 50% identical when optimally aligned using the ALIGN program. The term "corresponds to" is used herein to mean that a polynucleotide sequence is homologous (i.e., is identical, not strictly evolutionarily related) to all or a portion of a reference polynucleotide sequence, or that a polypeptide sequence is identical to a reference polypeptide sequence. In contradistinction, the term "complementary to" is used herein to mean that the complementary sequence is homologous to all or a portion of a reference polynucleotide sequence. For illustration, the nucleotide sequence "TATAC" corresponds to a reference sequence "TATAC" and is complementary to a reference sequence "GTATA".

The following terms are used to describe the sequence relationships between two or more polynucleotide or amino acid sequences: "reference sequence", "comparison window", "sequence identity", "percentage of sequence identity", and "substantial identity". A "reference sequence" is a defined sequence used as a basis for a sequence comparison a reference sequence may be a subset of a larger sequence, for example, as a segment of a full-length cDNA or gene sequence given in a sequence listing or may comprise a complete cDNA or gene sequence. Generally, a reference sequence is at least 18 nucleotides or 6 amino acids in length, frequently at least 24 nucleotides or 8 amino acids in length, and often at least 48 nucleotides or 16 amino acids in length. Since two polynucleotides or amino acid sequences may each (1) comprise a sequence (i.e., a portion of the complete polynucleotide or amino acid sequence) that is similar between the two molecules, and (2) may further comprise a sequence that is divergent between the two polynucleotides or amino acid sequences, sequence comparisons between two (or more) molecules are typically performed by comparing sequences of the two molecules over a "comparison window" to identify and compare local regions of sequence similarity. A "comparison window", as used herein, refers to a conceptual segment of at least 18 contiguous nucleotide positions or 6 amino acids wherein a polynucleotide sequence or amino acid sequence may be compared to a reference sequence of at least 18 contiguous nucleotides or 6 amino acid sequences and wherein the portion of the polynucleotide sequence in the comparison window may comprise additions, deletions, sub-

stitutions, and the like (i.e., gaps) of 20 percent or less as compared to the reference sequence (which does not comprise additions or deletions) for optimal alignment of the two sequences. Optimal alignment of sequences for aligning a comparison window may be conducted by the local homology algorithm of Smith and Waterman *Adv. Appl. Math.* 2:482 (1981), by the homology alignment algorithm of Needleman and Wunsch *J. Mol. Biol.* 48:443 (1970), by the search for similarity method of Pearson and Lipman *Proc. Natl. Acad. Sci. (U.S.A.)* 85:2444 (1988), by computerized implementations of these algorithms (GAP, BESTFIT, FASTA, and TFASTA in the Wisconsin Genetics Software Package Release 7.0, (Genetics Computer Group, 575 Science Dr., Madison, Wis.), Geneworks, or MacVector software packages), or by inspection, and the best alignment (i.e., resulting in the highest percentage of homology over the comparison window) generated by the various methods is selected.

The term "sequence identity" means that two polynucleotide or amino acid sequences are identical (i.e., on a nucleotide-by-nucleotide or residue-by-residue basis) over the comparison window. The term "percentage of sequence identity" is calculated by comparing two optimally aligned sequences over the window of comparison, determining the number of positions at which the identical nucleic acid base (e.g., A, T, C, G, U or I) or residue occurs in both sequences to yield the number of matched positions, dividing the number of matched positions by the total number of positions in the comparison window (i.e., the window size), and multiplying the result by 100 to yield the percentage of sequence identity. The terms "substantial identity" as used herein denotes a characteristic of a polynucleotide or amino acid sequence, wherein the polynucleotide or amino acid comprises a sequence that has at least 85 percent sequence identity, preferably at least 90 to 95 percent sequence identity, more usually at least 99 percent sequence identity as compared to a reference sequence over a comparison window of at least 18 nucleotide (6 amino acid) positions, frequently over a window of at least 24-48 nucleotide (8-16 amino acid) positions, wherein the percentage of sequence identity is calculated by comparing the reference sequence to the sequence which may include deletions or additions which total 20 percent or less of the reference sequence over the comparison window. The reference sequence may be a subset of a larger sequence.

As used herein, the twenty conventional amino acids and their abbreviations follow conventional usage. See *Immunology—A Synthesis* (2nd Edition, E. S. Golub and D. R. Gren, Eds., Sinauer Associates, Sunderland Mass. (1991)). Stereoisomers (e.g., D-amino acids) of the twenty conventional amino acids, unnatural amino acids such as α -, α -disubstituted amino acids, N-alkyl amino acids, lactic acid, and other unconventional amino acids may also be suitable components for polypeptides of the present invention. Examples of unconventional amino acids include: 4 hydroxyproline, γ -carboxyglutamate, ϵ -N,N,N-trimethyllysine, ϵ -N-acetyllysine, O-phosphoserine, N-acetylserine, N-formylmethionine, 3-methylhistidine, 5-hydroxylysine, σ -N-methylarginine, and other similar amino acids and imino acids (e.g., 4-hydroxyproline). In the polypeptide notation used herein, the lefthand direction is the amino terminal direction and the righthand direction is the carboxy-terminal direction, in accordance with standard usage and convention.

Similarly, unless specified otherwise, the lefthand end of single-stranded polynucleotide sequences is the 5' end the lefthand direction of double-stranded polynucleotide sequences is referred to as the 5' direction. The direction of 5'

to 3' addition of nascent RNA transcripts is referred to as the transcription direction sequence regions on the DNA strand having the same sequence as the RNA and which are 5' to the 5' end of the RNA transcript are referred to as "upstream sequences", sequence regions on the DNA strand having the same sequence as the RNA and which are 3' to the 3' end of the RNA transcript are referred to as "downstream sequences".

As applied to polypeptides, the term "substantial identity" means that two peptide sequences, when optimally aligned, such as by the programs GAP or BESTFIT using default gap weights, share at least 80 percent sequence identity, preferably at least 90 percent sequence identity, more preferably at least 95 percent sequence identity, and most preferably at least 99 percent sequence identity.

Preferably, residue positions which are not identical differ by conservative amino acid substitutions.

Conservative amino acid substitutions refer to the interchangeability of residues having similar side chains. For example, a group of amino acids having aliphatic side chains is glycine, alanine, valine, leucine, and isoleucine; a group of amino acids having aliphatic-hydroxyl side chains is serine and threonine; a group of amino acids having amide-containing side chains is asparagine and glutamine; a group of amino acids having aromatic side chains is phenylalanine, tyrosine, and tryptophan; a group of amino acids having basic side chains is lysine, arginine, and histidine; and a group of amino acids having sulfur-containing side chains is cysteine and methionine. Preferred conservative amino acid substitution groups are: valine-leucine-isoleucine, phenylalanine-tyrosine, lysine-arginine, alanine valine, glutamic-aspartic, and asparagine-glutamine.

As discussed herein, minor variations in the amino acid sequences of antibodies or immunoglobulin molecules are contemplated as being encompassed by the present invention, providing that the variations in the amino acid sequence maintain at least 75%, more preferably at least 80%, 90%, 95%, and most preferably 99%. In particular, conservative amino acid replacements are contemplated. Conservative replacements are those that take place within a family of amino acids that are related in their side chains. Genetically encoded amino acids are generally divided into families: (1) acidic amino acids are aspartate, glutamate; (2) basic amino acids are lysine, arginine, histidine; (3) non-polar amino acids are alanine, valine, leucine, isoleucine, proline, phenylalanine, methionine, tryptophan, and (4) uncharged polar amino acids are glycine, asparagine, glutamine, cysteine, serine, threonine, tyrosine. The hydrophilic amino acids include arginine, asparagine, aspartate, glutamine, glutamate, histidine, lysine, serine, and threonine. The hydrophobic amino acids include alanine, cysteine, isoleucine, leucine, methionine, phenylalanine, proline, tryptophan, tyrosine and valine. Other families of amino acids include (i) serine and threonine, which are the aliphatic-hydroxy family; (ii) asparagine and glutamine, which are the amide containing family; (iii) alanine, valine, leucine and isoleucine, which are the aliphatic family; and (iv) phenylalanine, tryptophan, and tyrosine, which are the aromatic family. For example, it is reasonable to expect that an isolated replacement of a leucine with an isoleucine or valine, an aspartate with a glutamate, a threonine with a serine, or a similar replacement of an amino acid with a structurally related amino acid will not have a major effect on the binding or properties of the resulting molecule, especially if the replacement does not involve an amino acid within a framework site. Whether an amino acid change results in a functional peptide can readily be determined by assaying the specific activity of the polypeptide derivative. Assays are described in detail herein. Fragments or analogs of

antibodies or immunoglobulin molecules can be readily prepared by those of ordinary skill in the art. Preferred amino- and carboxy-termini of fragments or analogs occur near boundaries of functional domains. Structural and functional domains can be identified by comparison of the nucleotide and/or amino acid sequence data to public or proprietary sequence databases. Preferably, computerized comparison methods are used to identify sequence motifs or predicted protein conformation domains that occur in other proteins of known structure and/or function. Methods to identify protein sequences that fold into a known three-dimensional structure are known. Bowie et al. *Science* 253:164 (1991). Thus, the foregoing examples demonstrate that those of skill in the art can recognize sequence motifs and structural conformations that may be used to define structural and functional domains in accordance with the invention.

Preferred amino acid substitutions are those which: (1) reduce susceptibility to proteolysis, (2) reduce susceptibility to oxidation, (3) alter binding affinity for forming protein complexes, (4) alter binding affinities, and (4) confer or modify other physicochemical or functional properties of such analogs. Analogous can include various muteins of a sequence other than the naturally-occurring peptide sequence. For example, single or multiple amino acid substitutions (preferably conservative amino acid substitutions) may be made in the naturally-occurring sequence (preferably in the portion of the polypeptide outside the domain(s) forming intermolecular contacts. A conservative amino acid substitution should not substantially change the structural characteristics of the parent sequence (e.g., a replacement amino acid should not tend to break a helix that occurs in the parent sequence, or disrupt other types of secondary structure that characterizes the parent sequence). Examples of art-recognized polypeptide secondary and tertiary structures are described in *Proteins, Structures and Molecular Principles* (Creighton, Ed., W. H. Freeman and Company, New York (1984)); *Introduction to Protein Structure* (C. Branden and J. Tooze, eds., Garland Publishing, New York, N.Y. (1991)); and Thornton et al. *Nature* 354:105 (1991).

The term "polypeptide fragment" as used herein refers to a polypeptide that has an amino terminal and/or carboxy-terminal deletion, but where the remaining amino acid sequence is identical to the corresponding positions in the naturally-occurring sequence deduced, for example, from a full length cDNA sequence. Fragments typically are at least 5, 6, 8 or 10 amino acids long, preferably at least 14 amino acids long, more preferably at least 20 amino acids long, usually at least 50 amino acids long, and even more preferably at least 70 amino acids long. The term "analog" as used herein refers to polypeptides which are comprised of a segment of at least 25 amino acids that has substantial identity to a portion of a deduced amino acid sequence and which has at least one of the following properties: (1) specific binding to IP-10, under suitable binding conditions or (2) ability to block appropriate IP-10 binding. Typically, polypeptide analogs comprise a conservative amino acid substitution (or addition or deletion) with respect to the naturally-occurring sequence. Analogous typically are at least 20 amino acids long, preferably at least 50 amino acids long or longer, and can often be as long as a full-length naturally-occurring polypeptide.

Peptide analogs are commonly used in the pharmaceutical industry as non-peptide drugs with properties analogous to those of the template peptide. These types of non-peptide compound are termed "peptide mimetics" or "peptidomimetics". Fauchere, J. *Adv. Drug Res.* 15:29 (1986), Veber and Freidinger *TINS* p. 392 (1985); and Evans et al. *J. Med. Chem.* 30:1229 (1987). Such compounds are often developed

with the aid of computerized molecular modeling. Peptide mimetics that are structurally similar to therapeutically useful peptides may be used to produce an equivalent therapeutic or prophylactic effect. Generally, peptidomimetics are structurally similar to a paradigm polypeptide (i.e., a polypeptide that has a biochemical property or pharmacological activity), such as human antibody, but have one or more peptide linkages optionally replaced by a linkage selected from the group consisting of: $-\text{CH}_2\text{NH}-$, $-\text{CH}_2\text{S}-$, $-\text{CH}_2-\text{CH}_2-$, $-\text{CH}=\text{CH}(\text{cis and trans})-$, $-\text{COCH}_2-$, $\text{CH}(\text{OH})\text{CH}_2-$, and $-\text{CH}_2\text{SO}-$, by methods well known in the art. Systematic substitution of one or more amino acids of a consensus sequence with a D-amino acid of the same type (e.g., D-lysine in place of L-lysine) may be used to generate more stable peptides. In addition, constrained peptides comprising a consensus sequence or a substantially identical consensus sequence variation may be generated by methods known in the art (Rizo and Gierasch *Ann. Rev. Biochem.* 61:387 (1992)); for example, by adding internal cysteine residues capable of forming intramolecular disulfide bridges which cyclize the peptide.

The term "agent" is used herein to denote a chemical compound, a mixture of chemical compounds, a biological macromolecule, or an extract made from biological materials.

As used herein, the terms "label" or "labeled" refers to incorporation of a detectable marker, e.g., by incorporation of a radiolabeled amino acid or attachment to a polypeptide of biotinyl moieties that can be detected by marked avidin (e.g., streptavidin containing a fluorescent marker or enzymatic activity that can be detected by optical or calorimetric methods). In certain situations, the label or marker can also be therapeutic. Various methods of labeling polypeptides and glycoproteins are known in the art and may be used. Examples of labels for polypeptides include, but are not limited to, the following: radioisotopes or radionuclides (e.g., ^3H , ^{14}C , ^{15}N , ^{35}S , ^{90}Y , ^{99}Tc , ^{111}In , ^{125}I , ^{131}I), fluorescent labels (e.g., FITC, rhodamine, lanthanide phosphors), enzymatic labels (e.g., horseradish peroxidase, p-galactosidase, luciferase, alkaline phosphatase), chemiluminescent, biotinyl groups, predetermined polypeptide epitopes recognized by a secondary reporter (e.g., leucine zipper pair sequences, binding sites for secondary antibodies, metal binding domains, epitope tags). In some embodiments, labels are attached by spacer arms of various lengths to reduce potential steric hindrance. The term "pharmaceutical agent or drug" as used herein refers to a chemical compound or composition capable of inducing a desired therapeutic effect when properly administered to a patient.

Other chemistry terms herein are used according to conventional usage in the art, as exemplified by The McGraw-Hill Dictionary of Chemical Terms (Parker, S., Ed., McGraw-Hill, San Francisco (1985)).

As used herein, "substantially pure" means an object species is the predominant species present (i.e., on a molar basis it is more abundant than any other individual species in the composition), and preferably a substantially purified fraction is a composition wherein the object species comprises at least about 50 percent (on a molar basis) of all macromolecular species present.

Generally, a substantially pure composition will comprise more than about 80 percent of all macromolecular species present in the composition, more preferably more than about 85%, 90%, 95%, and 99%. Most preferably, the object species is purified to essential homogeneity (contaminant species cannot be detected in the composition by conventional detection methods) wherein the composition consists essentially of a single macromolecular species.

The term patient includes human and veterinary subjects. The term subject includes humans and other mammals.

Human Antibodies and Humanization of Antibodies

A huIP-10 antibody is generated, for example, using the procedures described in the Examples provided below. An IgG huIP-10 antibody is generated, for example, by converting a scFv clone an IgG format (see e.g., Example 9). For example, huIP-10 antibodies are reformatted into an IgG1 isotype.

In other, alternative methods, a huIP-10 antibody is developed, for example, using phage-display methods using antibodies containing only human sequences. Such approaches are well-known in the art, e.g., in WO92/01047 and U.S. Pat. No. 6,521,404, which are hereby incorporated by reference.

In this approach, a combinatorial library of phage carrying random pairs of light and heavy chains are screened using natural or recombinant source of IP-10 or fragments thereof. In another approach, a huIP-10 antibody can be produced by a process wherein at least one step of the process includes immunizing a transgenic, non-human animal with human IP-10 protein. In this approach, some of the endogenous heavy and/or kappa light chain loci of this xenogenic non-human animal have been disabled and are incapable of the rearrangement required to generate genes encoding immunoglobulins in response to an antigen. In addition, at least one human heavy chain locus and at least one human light chain locus have been stably transfected into the animal. Thus, in response to an administered antigen, the human loci rearrange to provide genes encoding human variable regions immunospecific for the antigen. Upon immunization, therefore, the xenomouse produces B-cells that secrete fully human immunoglobulins.

A variety of techniques are well-known in the art for producing xenogenic non-human animals. For example, see U.S. Pat. No. 6,075,181 and U.S. Pat. No. 6,150,584, which is hereby incorporated by reference in its entirety. This general strategy was demonstrated in connection with generation of the first Xenomouse™ strains as published in 1994. See Green et al. *Nature Genetics* 7:13-21 (1994), which is hereby incorporated by reference in its entirety. See also, U.S. Pat. Nos. 6,162,963, 6,150,584, 6,114,598, 6,075,181, and 5,939,598 and Japanese Patent Nos. 3 068 180 B2, 3 068 506 B2, and 3 068 507 B2 and European Patent No., EP 0 463 151 B1 and International Patent Applications No. WO 94/02602, WO 96/34096, WO 98/24893, WO 00/76310 and related family members.

In an alternative approach, others have utilized a "minilocus" approach in which an exogenous Ig locus is mimicked through the inclusion of pieces (individual genes) from the Ig locus. Thus, one or more VH genes, one or more D_H genes, one or more J_H genes, a mu constant region, and a second constant region (preferably a gamma constant region) are formed into a construct for insertion into an animal. See e.g., U.S. Pat. Nos. 5,545,806; 5,545,807; 5,591,669; 5,612,205; 5,625,825; 5,625,126; 5,633,425; 5,643,763; 5,661,016; 5,721,367; 5,770,429; 5,789,215; 5,789,650; 5,814,318; 5,877; 397; 5,874,299; 6,023,010; and 6,255,458; and European Patent No. 0 546 073 B1; and International Patent Application Nos. WO 92/03918, WO 92/22645, WO 92/22647, WO 92/22670, WO 93/12227, WO 94/00569, WO 94/25585, WO 96/14436, WO 97/13852, and WO 98/24884 and related family members.

Generation of human antibodies from mice in which, through microcell fusion, large pieces of chromosomes, or entire chromosomes, have been introduced, has also been demonstrated. See European Patent Application Nos. 773 288 and 843 961.

Human anti-mouse antibody (HAMA) responses have led the industry to prepare chimeric or otherwise humanized antibodies. While chimeric antibodies have a human constant region and a immune variable region, it is expected that certain human anti-chimeric antibody (HACA) responses will be observed, particularly in chronic or multi-dose utilizations of the antibody. Thus, it would be desirable to provide fully human antibodies against IP-10 in order to vitiate concerns and/or effects of HAMA or HACA response.

The production of antibodies with reduced immunogenicity is also accomplished via humanization and display techniques using appropriate libraries. It will be appreciated that murine antibodies or antibodies from other species can be humanized or primatized using techniques well known in the art. See e.g., Winter and Harris *Immunol Today* 14:43-46 (1993) and Wright et al. *Crit. Reviews in Immunol.* 12:125-168 (1992). The antibody of interest may be engineered by recombinant DNA techniques to substitute the CH1, CH2, CH3, hinge domains, and/or the framework domain with the corresponding human sequence (See WO 92102190 and U.S. Pat. Nos. 5,530,101, 5,585,089, 5,693,761, 5,693,792, 5,714,350, and 5,777,085). Also, the use of Ig cDNA for construction of chimeric immunoglobulin genes is known in the art (Liu et al. *P.N.A.S.* 84:3439 (1987) and *J. Immunol.* 139:3521 (1987)). mRNA is isolated from a hybridoma or other cell producing the antibody and used to produce cDNA. The cDNA of interest may be amplified by the polymerase chain reaction using specific primers (U.S. Pat. Nos. 4,683,195 and 4,683,202). Alternatively, a library is made and screened to isolate the sequence of interest. The DNA sequence encoding the variable region of the antibody is then fused to human constant region sequences. The sequences of human constant regions genes may be found in Kabat et al. (1991) *Sequences of Proteins of immunological Interest*, N.I.H. publication no. 91-3242. Human C region genes are readily available from known clones. The choice of isotype will be guided by the desired effector functions, such as complement fixation, or activity in antibody-dependent cellular cytotoxicity. Preferred isotypes are IgG1, IgG3 and IgG4. Either of the human light chain constant regions, kappa or lambda, may be used. The chimeric, humanized antibody is then expressed by conventional methods.

Antibody fragments, such as Fv, F(ab')₂ and Fab may be prepared by cleavage of the intact protein, e.g., by protease or chemical cleavage. Alternatively, a truncated gene is designed. For example, a chimeric gene encoding a portion of the F(ab')₂ fragment would include DNA sequences encoding the CH1 domain and hinge region of the H chain, followed by a translational stop codon to yield the truncated molecule.

Consensus sequences of H and L J regions may be used to design oligonucleotides for use as primers to introduce useful restriction sites into the J region for subsequent linkage of V region segments to human C region segments. C region cDNA can be modified by site directed mutagenesis to place a restriction site at the analogous position in the human sequence.

Expression vectors include plasmids, retroviruses, YACs, EBV derived episomes, and the like. A convenient vector is one that encodes a functionally complete human CH or CL immunoglobulin sequence, with appropriate restriction sites engineered so that any VH or VL -31 sequence can be easily inserted and expressed. In such vectors, splicing usually occurs between the splice donor site in the inserted J region and the splice acceptor site preceding the human C region, and also at the splice regions that occur within the human CH exons. Polyadenylation and transcription termination occur at native chromosomal sites downstream of the coding regions.

The resulting chimeric antibody may be joined to any strong promoter, including retroviral LTRs, e.g., SV-40 early promoter, (Okayama et al. *Mol. Cell. Bio.* 3:280 (1983)), Rous sarcoma virus LTR (Gorman et al. *P.N.A.S.* 79:6777 (1982)), and moloney murine leukemia virus LTR (Grosschedl et al. *Cell* 41:885 (1985)). Also, as will be appreciated, native Ig promoters and the like may be used.

Further, human antibodies or antibodies from other species can be generated through display type technologies, including, without limitation, phage display, retroviral display, ribosomal display, and other techniques, using techniques well known in the art and the resulting molecules can be subjected to additional maturation, such as affinity maturation, as such techniques are well known in the art. Wright and Harris, supra., Hanes and Plutchau *PEAS USA* 94:4937-4942 (1997) (ribosomal display), Parmley and Smith *Gene* 73:305-318 (1988) (phage display), Scott *TIB5* 17:241-245 (1992), Cwirla et al. *PNAS USA* 87:6378-6382 (1990), Russel et al. *Nucl. Acids Research* 21:1081-1085 (1993), Hoganboom et al. *Immunol. Reviews* 130:43-68 (1992), Chiswell and McCafferty *TIBTECH*; 10:80-8A (1992), and U.S. Pat. No. 5,733,743. If display technologies are utilized to produce antibodies that are not human, such antibodies can be humanized as described above.

Using these techniques, antibodies can be generated to IP-10 expressing cells, IP-10 itself, forms of IP-10, epitopes or peptides thereof, and expression libraries thereto (See e.g., U.S. Pat. No. 5,703,057) which can thereafter be screened as described above for the activities described above.

30 Design and Generation of Other Therapeutics

In accordance with the present invention and based on the activity of the antibodies that are produced and characterized herein with respect to IP-10, the design of other therapeutic modalities beyond antibody moieties is facilitated. Such modalities include, without limitation, advanced antibody therapeutics, such as bispecific antibodies, immunotoxins, and radiolabeled therapeutics, generation of peptide therapeutics, gene therapies, particularly intrabodies, antisense therapeutics, and small molecules.

For example, in connection with bispecific antibodies, bispecific antibodies can be generated that comprise (i) two antibodies one with a specificity to IP-10 and another to a second molecule that are conjugated together, (ii) a single antibody that has one chain specific to IP-10 and a second chain specific to a second molecule, or (iii) a single chain antibody that has specificity to IP-10 and the other molecule. Such bispecific antibodies are generated using techniques that are well known for example, in connection with (i) and (ii) See e.g., Fanger et al. *Immunol Methods* 4:72-81 (1994) and Wright and Harris, supra, and in connection with (iii) See e.g., Traunecker et al. *Int. J. Cancer (Suppl.)* 7:51-52 (1992).

In connection with immunotoxins, antibodies can be modified to act as immunotoxins utilizing techniques that are well known in the art. See e.g., Vitetta *Immunol Today* 14:252 (1993). See also U.S. Pat. No. 5,194,594. In connection with the preparation of radiolabeled antibodies, such modified antibodies can also be readily prepared utilizing techniques that are well known in the art. See e.g., Junghans et al. in *Cancer Chemotherapy and Biotherapy* 655-686 (2d edition, Chafner and Longo, eds., Lippincott Raven (1996)). See also U.S. Pat. Nos. 4,681,581, 4,735,210, 5,101,827, 5,102,990 (RE 35,500), 5,648,471, and 5,697,902. Each of immunotoxins and radiolabeled molecules would be likely to kill cells expressing IP-10, and particularly those cells in which the antibodies of the invention are effective.

In connection with the generation of therapeutic peptides, through the utilization of structural information related to

IP-10 and antibodies thereto, such as the antibodies of the invention or screening of peptide libraries, therapeutic peptides can be generated that are directed against IP-10. Design and screening of peptide therapeutics is discussed in connection with Houghten et al. *Biotechniques* 13:412-421 (1992), Houghten *PNAS USA* 82:5131-5135 (1985), Pinalla et al. *Biotechniques* 13:901-905 (1992), Blake and Litzi-Davis *BioConjugate Chem.* 3:510-513 (1992). Immunotoxins and radiolabeled molecules can also be prepared, and in a similar manner, in connection with peptidic moieties as discussed above in connection with antibodies. Assuming that the IP-10 molecule (or a form, such as a splice variant or alternate form) is functionally active in a disease process, it will also be possible to design gene and antisense therapeutics thereto through conventional techniques. Such modalities can be utilized for modulating the function of IP-10. In connection therewith the antibodies of the present invention facilitate design and use of functional assays related thereto. A design and strategy for antisense therapeutics is discussed in detail in International Patent Application No. WO 94/29444. Design and strategies for gene therapy are well known. However, in particular, the use of gene therapeutic techniques involving intrabodies could prove to be particularly advantageous. See e.g., Chen et al. *Human Gene Therapy* 5:595-601 (1994) and Marasco *Gene Therapy* 4:11-15 (1997). General design of and considerations related to gene therapeutics is also discussed in International Patent Application No. WO 97/38137.

Knowledge gleaned from the structure of the IP-10 molecule and its interactions with other molecules in accordance with the present invention, such as the antibodies of the invention, and others can be utilized to rationally design additional therapeutic modalities. In this regard, rational drug design techniques such as X-ray crystallography, computer-aided (or assisted) molecular modeling (CAMM), quantitative or qualitative structure-activity relationship (QSAR), and similar technologies can be utilized to focus drug discovery efforts. Rational design allows prediction of protein or synthetic structures which can interact with the molecule or specific forms thereof which can be used to modify or modulate the activity of IP-10. Such structures can be synthesized chemically or expressed in biological systems. This approach has been reviewed in Capsey et al. *Genetically Engineered Human Therapeutic Drugs* (Stockton Press, NY (1988)). Further, combinatorial libraries can be designed and synthesized and used in screening programs, such as high throughput screening efforts.

Therapeutic Administration and Formulations

It will be appreciated that administration of therapeutic entities in accordance with the invention will be administered with suitable carriers, excipients, and other agents that are incorporated into formulations to provide improved transfer, delivery, tolerance, and the like. A multitude of appropriate formulations can be found in the formulary known to all pharmaceutical chemists: Remington's *Pharmaceutical Sciences* (15th ed, Mack Publishing Company, Easton, Pa. (1975)), particularly Chapter 87 by Blaug, Seymour, therein. These formulations include, for example, powders, pastes, ointments, jellies, waxes, oils, lipids, lipid (cationic or anionic) containing vesicles (such as Lipofectin™), DNA conjugates, anhydrous absorption pastes, oil-in-water and water-in-oil emulsions, emulsions carbowax (polyethylene glycols of various molecular weights), semi-solid gels, and semi-solid mixtures containing carbowax. Any of the foregoing mixtures may be appropriate in treatments and therapies in accordance with the present invention, provided that the active ingredient in the formulation is not inactivated by the formulation and the formulation is physiologically compat-

ible and tolerable with the route of administration. See also Baldrick P. "Pharmaceutical excipient development: the need for preclinical guidance." *Regul. Toxicol Pharmacol.* 32(2): 210-8 (2000), Wang W. "Lyophilization and development of solid protein pharmaceuticals." *Int. J. Pharm.* 203 (1-2):1-60 (2000), Charman WN "Lipids, lipophilic drugs, and oral drug delivery-some emerging concepts." *J Pharm Sci.* 89(8):967-78 (2000), Powell et al. "Compendium of excipients for parenteral formulations" *PDA J Pharm Sci Technol.* 52:238-311 (1998) and the citations therein for additional information related to formulations, excipients and carriers well known to pharmaceutical chemists.

The huIP-10 antibodies and therapeutic formulations of the invention, which include a huIP-10 antibody of the invention, are used to treat or alleviate a symptom associated with an immune-related disorder, such as, for example, an autoimmune disease or an inflammatory disorder.

Autoimmune diseases include, for example, Acquired Immunodeficiency Syndrome (AIDS, which is a viral disease with an autoimmune component), alopecia areata, ankylosing spondylitis, antiphospholipid syndrome, autoimmune Addison's disease, autoimmune hemolytic anemia, autoimmune hepatitis, autoimmune inner ear disease (AIED), autoimmune lymphoproliferative syndrome (ALPS), autoimmune thrombocytopenic purpura (ATP), Behcet's disease, cardiomyopathy, celiac sprue-dermatitis hepeticiformis; chronic fatigue immune dysfunction syndrome (CFIDS), chronic inflammatory demyelinating polyneuropathy (CIPD), cicatricial pemphigoid, cold agglutinin disease, crest syndrome, Crohn's disease, Degos' disease, dermatomyositis-juvenile, discoid lupus, essential mixed cryoglobulinemia, fibromyalgia-fibromyositis, Graves' disease, Guillain-Barré syndrome, Hashimoto's thyroiditis, idiopathic pulmonary fibrosis, idiopathic thrombocytopenia purpura (ITP), IgA nephropathy, insulin-dependent diabetes mellitus, juvenile chronic arthritis (Still's disease), juvenile rheumatoid arthritis, Ménière's disease, mixed connective tissue disease, multiple sclerosis, myasthenia gravis, pernicious anemia, polyarteritis nodosa, polyarthritides, polyglandular syndromes, polymyalgia rheumatica, polymyositis and dermatomyositis, primary agammaglobulinemia, primary biliary cirrhosis, psoriasis, psoriatic arthritis, Raynaud's phenomena, Reiter's syndrome, rheumatic fever, rheumatoid arthritis, sarcoidosis, scleroderma (progressive systemic sclerosis (PSS), also known as systemic sclerosis (SS)), Sjögren's syndrome, stiff-man syndrome, systemic lupus erythematosus, Takayasu arteritis, temporal arteritis/giant cell arteritis, ulcerative colitis, uveitis, vitiligo and Wegener's granulomatosis.

Inflammatory disorders include, for example, chronic and acute inflammatory disorders. Examples of inflammatory disorders include Alzheimer's disease, asthma, atopic allergy, allergy, atherosclerosis, bronchial asthma, eczema, glomerulonephritis, graft vs. host disease, hemolytic anemias, osteoarthritis, sepsis, stroke, transplantation of tissue and organs, vasculitis, diabetic retinopathy and ventilator induced lung injury.

The huIP-10 antibodies modulate an immune response in a subject, e.g., in a human subject. In one embodiment, the huIP-10 antibody compositions used to treat an immune-related disorder are administered in combination with any of a variety of anti-cytokine agents or anti-chemokine agents. Suitable anti-cytokine or anti-chemokine reagents recognize, for example, cytokines such as interleukin 1 (IL-1), IL-2, IL-4, IL-6, IL-12, IL-13, IL-15, IL-17, IL-18, IL-20, IL-21, IL-22, IL-23, IL-27 and IL-31, and/or chemokines such as MIP1 alpha, MIP1 beta, RANTES, MCP1, IP-10, ITAC, MIG, SDF and fractalkine.

In one embodiment, the huIP-10 antibodies and the huIP-10 antibody compositions used to treat an immune-related disorder are administered in conjunction with one or more additional agents, or a combination of additional agents. For example, the huIP-10 antibody and additional agent are formulated into a single therapeutic composition, and the huIP-10 antibody and additional agent are administered simultaneously. Alternatively, the huIP-10 antibody and additional agent are separate from each other, e.g., each is formulated into a separate therapeutic composition, and the huIP-10 antibody and the additional agent are administered simultaneously, or the huIP-10 antibody and the additional agent are administered at different times during a treatment regimen. For example, the huIP-10 antibody is administered prior to the administration of the additional agent, the huIP-10 antibody is administered subsequent to the administration of the additional agent, or the huIP-10 antibody and the additional agent are administered in an alternating fashion. As described herein, the huIP-10 antibody and additional agent are administered in single doses or in multiple doses.

For example, in the treatment of multiple sclerosis, the huIP-10 antibody, or therapeutic formulation thereof, is administered in conjunction with one or more additional agents such as interferon beta 1a, interferon beta 1b, glatiramer acetate, natalizumab, copaxone, and combinations thereof. The huIP-10 antibody and the additional agent are administered simultaneously, or the huIP-10 antibody and the additional agent are administered at different times during a treatment regimen.

In the treatment of Crohn's disease, the huIP-10 antibody, or therapeutic formulation thereof, is administered in conjunction with one or more additional agents such as an antibiotic, an aminosalicylate, Infliximab, Adalimumab, and combinations thereof. Suitable antibiotics include, e.g., metronidazole and/or ciprofloxacin. Suitable aminosalicylates include, for example, mesalamine and/or sulfasalazine. The huIP-10 antibody and the additional agent are administered simultaneously, or the huIP-10 antibody and the additional agent are administered at different times during a treatment regimen.

In the treatment of ulcerative colitis, the huIP-10 antibody, or therapeutic formulation thereof, is administered in conjunction with one or more additional agents such as 6-mercaptopurine, azathioprine, Infliximab and combinations thereof. The huIP-10 antibody and the additional agent are administered simultaneously, or the huIP-10 antibody and the additional agent are administered at different times during a treatment regimen.

In the treatment of psoriasis, the huIP-10 antibody, or therapeutic formulation thereof, is administered in conjunction with one or more additional agents such as alefacept, efalizumab, Adalimumab, Infliximab, cyclosporine, Methotrexate, and combinations thereof. The huIP-10 antibody and the additional agent are administered simultaneously, or the huIP-10 antibody and the additional agent are administered at different times during a treatment regimen.

In the treatment of atherosclerosis, the huIP-10 antibody, or therapeutic formulation thereof, is administered in conjunction with one or more additional agents such as warfarin, a cholesterol lowering drug, and combinations thereof. Suitable cholesterol lowering drugs include, for example, statins and fibrates. The huIP-10 antibody and the additional agent are administered simultaneously, or the huIP-10 antibody and the additional agent are administered at different times during a treatment regimen.

The huIP-10 antibodies and therapeutic formulations thereof are used in methods of treating or alleviating a symp-

tom associated with an immune-related disorder. For example, the compositions of the invention are used to treat or alleviate a symptom of any of the autoimmune diseases and inflammatory disorders described herein. Symptoms associated with immune-related disorders include, for example, inflammation, fever, loss of appetite, weight loss, abdominal symptoms such as, for example, abdominal pain, diarrhea or constipation, joint pain or aches (arthralgia), fatigue, rash, anemia, extreme sensitivity to cold (Raynaud's phenomenon), muscle weakness, muscle fatigue, changes in skin or tissue tone, shortness of breath or other abnormal breathing patterns, chest pain or constriction of the chest muscles, abnormal heart rate (e.g., elevated or lowered), light sensitivity, blurry or otherwise abnormal vision, and reduced organ function.

The huIP-10 antibody and therapeutic formulations thereof are administered to a subject suffering from an immune-related disorder, such as an autoimmune disease or an inflammatory disorder. A subject suffering from an autoimmune disease or an inflammatory disorder is identified by methods known in the art. For example, subjects suffering from an autoimmune disease such as Crohn's disease, lupus or psoriasis, are identified using any of a variety of clinical and/or laboratory tests such as, physical examination, radiologic examination and blood, urine and stool analysis to evaluate immune status. For example, patients suffering from lupus are identified, e.g., by using the anti-nuclear antibody test (ANA) to determine if auto-antibodies to cell nuclei are present in the blood. Patients suffering from Crohn's are identified, e.g., using an upper gastrointestinal (GI) series and/or a colonoscopy to evaluate the small and large intestines, respectively. Patients suffering from psoriasis are identified, e.g., using microscopic examination of tissue taken from the affected skin patch, while patients suffering from rheumatoid arthritis are identified using, e.g., blood tests and/or x-ray or other imaging evaluation. Patients suffering from atherosclerosis are identified, e.g., using blood tests, electrocardiograms (ECG), stress testing, coronary angiography, ultrasound, and computed tomography (CT).

Administration of a huIP-10 antibody to a patient suffering from an immune-related disorder such as an autoimmune disease or an inflammatory disorder is considered successful if any of a variety of laboratory or clinical results is achieved. For example, administration of a huIP-10 antibody to a patient suffering from an immune-related disorder such as an autoimmune disease or an inflammatory disorder is considered successful one or more of the symptoms associated with the disorder is alleviated, reduced, inhibited or does not progress to a further, i.e., worse, state. Administration of a huIP-10 antibody to a patient suffering from an immune-related disorder such as an autoimmune disease or an inflammatory disorder is considered successful if the disorder, e.g., an autoimmune disorder, enters remission or does not progress to a further, i.e., worse, state.

Diagnostic and Prophylactic Formulations

The fully human anti-IP-10 MAbs of the invention are used in diagnostic and prophylactic formulations. In one embodiment, a huIP-10 MAb of the invention is administered to patients that are at risk of developing one of the aforementioned autoimmune diseases. A patient's predisposition to one or more of the aforementioned autoimmune diseases can be determined using genotypic, serological or biochemical markers.

In another embodiment of the invention, a huIP-10 antibody is administered to human individuals diagnosed with one or more of the aforementioned autoimmune diseases.

Upon diagnosis, a huIP-10 antibody is administered to mitigate or reverse the effects of autoimmunity.

Antibodies of the invention are also useful in the detection of IP-10 in patient samples and accordingly are useful as diagnostics. For example, the huIP-10 antibodies of the invention are used in *in vitro* assays, e.g., ELISA, to detect IP-10 levels in a patient sample.

In one embodiment, a huIP-10 antibody of the invention is immobilized on a solid support (e.g., the well(s) of a microtiter plate). The immobilized antibody serves as a capture antibody for any IP-10 that may be present in a test sample. Prior to contacting the immobilized antibody with a patient sample, the solid support is rinsed and treated with a blocking agent such as mink protein or albumin to prevent nonspecific adsorption of the analyte.

Subsequently the wells are treated with a test sample suspected of containing the antigen, or with a solution containing a standard amount of the antigen. Such a sample is, e.g., a serum sample from a subject suspected of having levels of circulating antigen considered to be diagnostic of a pathology. After rinsing away the test sample or standard, the solid support is treated with a second antibody that is detectably labeled. The labeled second antibody serves as a detecting antibody. The level of detectable label is measured, and the concentration of IP-10 antigen in the test sample is determined by comparison with a standard curve developed from the standard samples.

It will be appreciated that based on the results obtained using the huIP-10 antibodies of the invention in an *in vitro* diagnostic assay, it is possible to stage a disease (e.g., an autoimmune or inflammatory disorder) in a subject based on expression levels of the IP-10 antigen. For a given disease, samples of blood are taken from subjects diagnosed as being at various stages in the progression of the disease, and/or at various points in the therapeutic treatment of the disease. Using a population of samples that provides statistically significant results for each stage of progression or therapy, a range of concentrations of the antigen that may be considered characteristic of each stage is designated.

All publications and patent documents cited herein are incorporated herein by reference as if each such publication or document was specifically and individually indicated to be incorporated herein by reference. Citation of publications and patent documents is not intended as an admission that any is pertinent prior art, nor does it constitute any admission as to the contents or date of the same. The invention having now been described by way of written description, those of skill in the art will recognize that the invention can be practiced in a variety of embodiments and that the foregoing description and examples below are for purposes of illustration and not limitation of the claims that follow.

EXAMPLES

The following examples, including the experiments conducted and results achieved are provided for illustrative purposes only and are not to be construed as limiting upon the present invention.

Example 1

Cloning, Expression and Purification of Human IP-10

Cloning

The gene encoding the mature protein human IP-10 (hIP10) (NM001565) was cloned in an expression plasmid pET43

(Novagen Madison, Wis.) by PCR amplification. The sequence for the Factor X protease cleavage site was introduced at the C-terminus of NusA. The sequence for the Avi-Tag (Avidity, Denver Colo.) biotinylation site was introduced at the C-terminus of the chemokine coding sequence. The pET-derived plasmids were used for the co-transformation of bacterial strain Origami B with pACYC184-BirA plasmid that encodes the biotin ligase gene.

Expression of NusA-hIP-10 Fusion Protein

An overnight culture of bacteria harboring the expression construct was diluted 1:30 into Terrific broth (InvitroGen) containing 50 µg/mL Ampicillin, 10 µg/mL Kanamycin, 5 µg/mL Tetracycline, 20 µg/mL Chloramphenicol and 50 µM Biotin. The culture was incubated at 37° C. with shaking until OD 600=0.7 was reached. IPTG was then added to a final concentration of 1 mM, incubated for 15 min. at 37° C. and overnight at 25° C.

Purification and Cleavage Of Fusion Proteins

Bacterial pellets were resuspended in Bugbuster (Novagen) containing Benzonase Nuclease and protease inhibitor Complete EDTA-free (Roche) and incubated for 1 hour at 4° C. The soluble and insoluble fractions were separated by centrifugation at 10,000 g for 15 min at 4° C. Soluble and insoluble protein fractions were analyzed by SDS-PAGE (Novex gels, InvitroGen). The soluble fraction was diluted ½ with Buffer A (Tris-HCl 100 mM pH 8.0, NaCl 600 mM, CaCl₂ 10 mM, Imidazole 40 mM), mixed with 50% (v/v) Ni-NTA agarose (Qiagen) previously equilibrated in Buffer B (Tris-HCl 50 mM pH 8.0, NaCl 300 mM, CaCl₂ 5 mM, Imidazole 20 mM). The mixture was incubated for 30 min at RT with gentle shaking. The beads obtained after centrifugation were loaded in Poly-Prep chromatography columns (Biorad), washed three times with 5 volumes of Buffer B and eluted with Buffer C (Tris-HCl 50 mM pH 8.0, NaCl 200 mM, CaCl₂ 5 mM, Imidazole 400 mM). Elution fractions containing the protein were pooled and desalted using PD-10 columns (Amersham). NusA-chemokine fusion proteins were cleaved by Factor X (Novagen, Madison, Wis.) by incubating 1 mg protein with 25 U Factor X at 30° C. for up to 24 h in cleavage buffer (Tris-HCl 50 mM pH 8.0, NaCl 200 mM, CaCl₂ 5 mM). For some of the fusions proteins, the parameters for optimal cleavage were slightly different but were easily determined by varying incubation time (4-24 h) and/or temperature (25-37° C.). The cleaved protein was analyzed by SDS-PAGE and the activity tested by chemotaxis.

Example 2

Cloning, Expression of hCXCR3, the Receptor of hIP-10

A murine pre B lymphoma L1.2 cell line that stably expresses a chemokine receptor was generated by transfection. The cDNA encoding hCXCR3 was cloned by PCR using lymph node cDNA (Clontech, Palo Alto, Calif.) as a template. The PCR product was digested with Xba I and Not I and ligated into mammalian expression vector pCDNA 3.1-C (Invitrogen) The sequence of the coding region of the receptor was verified by sequencing. L1.2 cells (5×10⁶) were transfected by electroporation with 20 µg of linearized CXCR3 expression plasmid. Stable clones of receptor-expressing L1.2 cells were established by limiting dilution in the presence of 1 mg/mL Geneticin.

Receptor expression level was determined by flow cytometry (FACScan, Becton Dickinson, Mountain View, Calif.) using monoclonal antibody directed against hCXCR3 (Sigma, St. Louis, Mo.).

Example 3

Production of Native Human IP-10

THP1 cells were cultured in 10 ml media at a concentration at 1×10^6 /ml with 50 ng/ml recombinant human interferon gamma (IFN γ). Following overnight incubation at 37° C., cells were centrifuged, supernatant was collected and the concentration of IP-10 calculated via an ELISA assay.

Example 4

Cells Expressing Human IP-10 on Cell Surface

Chinese hamster ovary (CHO) cells (available from American Type Culture Collection (ATCC)) were stably transfected with c-myc-tagged human IP-10 cDNA that was subcloned into pCDNA 3.1 plasmids (Invitrogen, Carlsbad Calif.) containing neomycin resistance genes. Transfectants were selected by using this antibiotic, and successive cell sorting was accomplished by flow cytometry using an anti-6 \times His (Sigma) antibody. Surface expression of human IP-10 was confirmed via flow cytometry using an anti-IP-10 mAb 266 (R&D Systems, Minneapolis Minn.).

Example 5

Screening of Human scFv Libraries

General procedures for construction and handling of human scFv libraries are described in Vaughan et al., (Nat. Biotech. 1996, 14:309-314), hereby incorporated by reference in its entirety. Libraries of human scFv were screened against hIP-10 according to the following procedure.

Liquid Phase Selections.

Aliquots of scFv phage libraries (10^{12} Pfu) obtained from Cambridge Antibody Technology (Cambridge, UK) were blocked with PBS containing 3% (w/v) skimmed milk for one hour at room temperature on a rotary mixer. Blocked phage was then deselected on streptavidin magnetic beads (DynaM-280) for one hour at room temperature on a rotary mixer. Deselected phage was then incubated with in vivo biotinylated hIP-10 (100 nM) for two hours at room temperature on a rotary mixer. This selection step was performed either on NusA-hIP-10 biotinylated fusion protein or on biotinylated-hIP-10 released from the fusion by proteolytic cleavage. Beads were captured using a magnetic stand followed by four washes with PBS/0.1% Tween 20 and 3 washes with PBS. Beads were then directly added to 10 ml of exponentially growing TG1 cells and incubated for one hour at 37° C. with slow shaking (100 rpm). An aliquot of the infected TG1 was serially diluted to titer the selection output. The remaining infected TG1 were spun at 3000 rpm for 15 minutes and re-suspended in 0.5 ml 2 \times TY-AG (2 \times TY media containing 100 μ g/ml ampicillin and 2% glucose) and spread on 2 \times TYAG agar Bioassay plates. After overnight incubation at 30° C. 10 ml of 2 \times TYAG was added to the plates and the cells were scraped from the surface and transferred to a 50 ml polypropylene tube. 2 \times TYAG containing 50% glycerol was added to the cell suspension to obtain a final concentration of 17% glycerol. Aliquots of the selection round were kept at -80° C.

Cell Surface Selections.

Aliquots of scFv phage libraries (10^{12} Pfu) obtained from Cambridge Antibody Technology (Cambridge, UK) were blocked with PBS containing 3% (w/v) skimmed milk for one

hour at room temperature on a rotary mixer. Blocked phage was then deselected for one hour at 37° C./5% CO $_2$ on CHO cells transfected with an empty pDisplay vector (in a T75 flask 80% confluence) and that had been previously blocked with PBS containing 2% (w/v) skimmed milk. Deselected phage was then incubated CHO-pDisplay-hIFN γ cells for one hour at room temperature with gentle shaking. Cells were then washed ten times with PBS. Bound phage was eluted by adding directly 10 ml of exponentially growing TG1 to the T75 flask and incubating for one hour at 37° C. with slow shaking. An aliquot of the infected TG1 was serially diluted to titer the selection output. Infected TG1 were spun at 3000 rpm for 15 minutes and re-suspended in 0.5 ml 2 \times TY-AG (2 \times TY media containing 100 μ g/ml ampicillin and 2% glucose) and spread on 2 \times TYAG agar Bioassay plates. After overnight incubation at 30° C. 10 ml of 2 \times TYAG was added to the plates and the cells were scraped from the surface and transferred to a 50 ml polypropylene tube. 2 \times TYAG containing 50% glycerol was added to the cell suspension to obtain a final concentration of 17% glycerol. Aliquots of the selection round were kept at -80° C.

Phage Rescue.

100 μ l of cell suspension obtained from previous selection rounds were added to 20 ml of 2 \times TYAG and grown at 37° C. with agitation (240 rpm) until an OD $_{600}$ of 0.3 to 0.5 was reached. The culture was then super-infected with 3.3×10^{10} MK13K07 helper phage and incubated for one hour at 37° C. (150 rpm). The medium was then changed by centrifugating the cells at 2000 rpm for 10 minutes, removing the medium and resuspending the pellet in 20 ml of 2 \times TY-AK (100 μ g/ml ampicillin; 50 μ g/ml kanamycin). The culture was then grown overnight at 30° C. (240 rpm).

Monoclonal Phage Rescue for ELISA.

Single clones were picked into a microtiter plate containing 150 μ l of 2 \times TYAG media (2% glucose) per well and grown at 37° C. (100-120 rpm) for 5-6 h. M13K07 helper phage was added to each well to obtain a multiplicity of infection (MOI) of 10 (i.e., 10 phage for each cell in the culture) and incubated at 37° C. (100 rpm) for 1 h. Following growth, plates were centrifuged at 3,200 rpm for 10 min. Supernatant was carefully removed, cells re-suspended in 150 μ l 2 \times TYAK medium and grown overnight at 30° C. (120 rpm). For the ELISA, the phage are blocked by adding 150 μ l of 2 \times concentration PBS containing 5% skimmed milk powder followed by one hour incubation at room temperature. The plates were then centrifuged 10 minutes at 3000 rpm and the phage containing supernatant used for the ELISA.

Phage ELISA.

ELISA plates (Maxisorb, NUNC) were coated overnight with 2 μ g/ml hIFN γ in PBS. Control plates were coated with 2 μ g/ml BSA. Plates were then blocked with 3% skimmed milk/PBS at room temperature for 1 h. Plates were washed 3 times with PBS 0.05% Tween 20 before transferring the pre-blocked phage supernatants and incubation for one hour at room temperature. Plates were then washed 3 times with PBS 0.05% Tween 20. 50 μ l of 3% skimmed milk/PBS containing (HRP)-conjugated anti-M13 antibody (Amersham, diluted 1:10,000) to each well. Following incubation at room temperature for 1 hr, the plates were washed 5 times with PBS 0.05% Tween 20. The ELISA was then revealed by adding 50 μ l of TMB (Sigma) and 50 μ l of 2N H $_2$ SO $_4$ to stop the reaction. Absorption intensity was read at 450 nm.

Phage Clone Sequencing

Single clones were placed in a microtiter plate containing 150 μ l of 2 \times TYAG media (2% glucose) per well and grown at

30° C. (120 rpm) overnight. The next day 5 µl of culture was transferred into another plate containing 45 µl of dH₂O and mixed. The plates was then frozen at -20° C. After thawing, 1 µl of this suspension was used for PCR amplification using standard PCR protocols with primer specific for pCANTAB6: mycseq, 5'-CTCTTCTGAGATGAGTTTTTG-3' (SEQ ID NO: 130) and gene3leader, 5'-TTATTATTCG-CAATTCCTTTAGTTGTTTCCT-3' (SEQ ID NO: 131).

The PCR reactions were purified in 96 well format using the Montage PCRµ196 system (Millipore). 5 µl of the eluted DNA was sequencing using the mycseq and gene3leader primers.

ScFv Periplasmic Preparation for Functional Tests.

Individual clones were inoculated into a deep well microtiter plate containing 0.9 ml of 2×TYAG media (0.1% glucose) per well and grown at 37° C. for 5-6 h (250 rpm). 100 µl per well of 0.2 mM IPTG in 2×TY medium were then added to give a final concentration of 0.02 mM IPTG. Plates were then incubated overnight at 30° C. with shaking at 250 rpm. The deep-well plates were centrifuged at 2,500 rpm for 10 min and the supernatant carefully removed. The pellets were re-suspended in 150 µl TES buffer (50 mM Tris/HCl (pH 8), 1 mM EDTA (pH 8), 20% sucrose, complemented with Complete protease inhibitor, Roche). A hypotonic shock was produced by adding 150 µl of diluted TES buffer (1:5 TES:water dilution) and incubation on ice for 30 min. Plates were then centrifuged at 4000 rpm for 10 minutes to remove cells and debris. The supernatants were carefully transferred into another microtiter plate and kept on ice for immediate testing in functional assays or ELISAs.

Large Scale scFv Purification

A starter culture of 1 ml of 2×TYAG was inoculated with a single colony from a freshly streaked 2×TYAG agar plate and incubated with shaking (240 rpm) at 37° C. for 5 hours. 0.9 ml of this culture was used to inoculate a 400 ml culture of the same media and was grown overnight at 30° C. with vigorous shaking (300 rpm).

The next day the culture was induced by adding 400 µl of 1M IPTG and incubation was continued for an additional 3 hours. The cells were collected by centrifugation at 5,000 rpm for 10 minutes at 4° C. Pelleted cells were resuspended in 10 ml of ice-cold TES buffer complemented with protease inhibitors as described above. Osmotic shock was achieved by adding 15 ml of 1:5 diluted TES buffer and incubation for 1 hour on ice. Cells were centrifuged at 10,000 rpm for 20 minutes at 4° C. to pellet cell debris. The supernatant was carefully transferred to a fresh tube. Imidazole was added to the supernatant to a final concentration of 10 mM. 1 ml of Ni-NTA resin (Qiagen), equilibrated in PBS was added to each tube and incubated on a rotary mixer at 4° C. (20 rpm) for 1 hour.

The tubes were centrifuged at 2,000 rpm for 5 minutes and the supernatant carefully removed. The pelleted resin was resuspended in 10 ml of cold (4° C.) Wash buffer 1 (50 mM NaH₂PO₄, 300 mM NaCl, 10 mM imidazole, pH to 8.0). The suspension was added to a polyprep column (Biorad). 8 ml of cold Wash Buffer 2 (50 mM NaH₂PO₄, 300 mM NaCl, 20 mM imidazole, pH to 8.0) were used to wash the column by gravity flow. The scFv were eluted from the column with 2 ml of Elution buffer (50 mM NaH₂PO₄, 300 mM NaCl, 250 mM imidazole, pH to 8.0). Fractions were analyzed by absorption at 280 nm and protein containing fractions were pooled before buffer exchange on a PD10 desalting column (Amersham) equilibrated with PBS. The scFv in PBS were analyzed by SDS-PAGE and quantified by absorption at 280 nm. The purified scFv were aliquoted and stored at -20° C. and at 4° C.

Example 6

Inhibition of hIP-10 Induced Calcium Flux Using scFv Extracts

Periplasmic extracts of various hIP-10 scFv were produced as described above. L1.2 cells expressing hCXCR3 were cultured in RPMI medium supplemented with 10% FCS. Extracts containing the scFv were incubated with 2-10 nM of hIP-10 (Peprotech, Rocky Hill N.J.) for 30 minutes at room temperature. Cells were washed in PBS and loaded with 2 µM Fura 2/AM. 100 µl of loaded cells were added to each well of a 96-well black, transparent flat-bottom plate and calcium flux kinetics were recorded by measuring the fluorescence at 514 nm upon excitation at 340 or 380 nm on a Flex station II instrument (Molecular Devices). The inhibitory activity of each scFv extract was assessed by comparison to an extract containing an irrelevant scFv. The positive scFv candidates were expressed in larger scale as described above in Example 5 and confirmed in dose-response experiments in calcium flux assays (Table 4).

TABLE 4

Potency of antibodies tested in scFv format in chemotaxis and calcium flux functional assays.

Clone ID	Chemotaxis IC ₅₀ (nM)	Calcium flux IC ₅₀ (nM)
CF1N1R3P4_C7	0.12 [§]	ND
CF1H1R3P3_G11	0.39 [§]	7.8
CF1H1R3P4_B5	0.51 [§]	2.4
CF1A11R3P3_F3	1.8	14
CE7C1R3H8_J9	0.9	ND
CC21R3P1_F1	18 [¶]	36
CC21R3P1_B9	107	107
CB21R3P3_E5	36 [¶]	39
CC21R3P1_H6	36	71
CC21R3P5_C5	90	89
CB1R3P4_D3	72	179
CB2R2P4_C3	15	14
CC21R3P4_F4	36	107
CC21R3P1_C1a	108	37
CC21R3P3_C1	72	71
CC21R3P1_E7	71 [¶]	250
CB21R3P1_F1	40 [¶]	36
CC21R3P1_A2	7	36
CB21R3P6_G7	10	46

Chemotaxis was performed using either 2 nM[¶], 1 nM, or 0.2 nM[§] of hIP-10, while calcium flux was induced with 10 nM of hIP-10. Antibodies in the top part of the table were obtained after affinity maturation.

Example 7

ScFv Inhibition of hIP-10-Induced Cell Chemotaxis

Wild type L1.2 cells and L1.2 cells expressing hCXCR3 were cultured in RPMI medium supplemented with 10% FCS. The day before the experiment cells were incubated with 0.6 mg/ml of butyric acid. Different concentrations of purified scFv were incubated with 0.2-10 nM rhIP-10 and placed in the bottom chamber of chemotaxis 96-well plate (Neuroprobe). The filter plate was placed on top of the chemotaxis plate and each well was overlaid with 20 µl of a 10⁶ cells/ml suspension. The plate was incubated for 2 hours at 37° C. Cells that migrated through the filter were stained with DRAQ5 (Alexis Corporation) and counted on an FMAT 8200 reader (Applied Biosystems, Foster City Calif.). The IC₅₀ (where 50% of the hIP-10 induced cell migration is

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inhibited, i.e., 50% inhibitory concentration), for each candidate antibody was determined (Table 4).

Example 8

Reformatting scFv into IgG Format

The V_H and V_L sequence of selected scFv were amplified with specific oligonucleotides introducing a leader sequence and a HindIII restriction site at the 5' end. An ApaI or an AvrII site was introduced at the 3' end of the heavy and light chain sequence, respectively. The amplified V_H sequences were digested HindIII/ApaI and cloned into the pCon_γ1 expression vector (LONZA, Basel, Switzerland). The amplified V_L sequences were digested HindIII/AvrII and cloned into the pCon_λ2 expression vector (LONZA). The constructions were verified by sequencing before transfection into mammalian cells.

The V_H and V_L cDNA sequences in their appropriate expression vectors were transfected into mammalian cells using the Fugene 6 Transfection Reagent (Roche, Basel, Switzerland). Briefly, Peak cells were cultured in 6-well plates at a concentration of 6×10^5 cells per well in 2 ml culture media containing fetal bovine serum. The expression vectors, encoding the candidate V_H and V_L sequences, were co-transfected into the cells using the Fugene 6 Transfection Reagent according to manufacturer's instructions. One day following transfection, the culture media was aspirated, and 3 ml of fresh serum-free media was added to cells and cultured for three days at 37° C. Following three days culture period, the supernatant was harvested for IgG purified on protein G-Sepharose 4B fast flow columns (Sigma, St. Louis, Mo.) according to manufacturer's instructions. Briefly, supernatants from transfected cells were incubated overnight at 4° C. with ImmunoPure (G) IgG binding buffer (Pierce, Rockford Ill.). Samples were then passed over Protein G-Sepharose 4B fast flow columns and the IgG consequently purified using elution buffer. The eluted IgG fraction was then dialyzed against PBS and the IgG content quantified by absorption at 280 nm. Purity and IgG integrity were verified by SDS-PAGE.

The nucleic acid and amino acid sequences of the IgG1 reformatted NI-0801 antibody is shown below:

```
>NI-0801 Light Chain Amino Acid Sequence
                                     (SEQ ID NO: 134)
NFMLTQPHSVSESPGKTVTISCTGSGGSIASNYVQWYQQRPGSSPTTVIY
EDNQRPSPGVDRFSGSIDSSNSASLTISGLKTEDEADYYCQSYDPLPVW
VFGGGTKLTVLQPKAAPSVTLFPPSSEELQANKATLVCLISDFYPGAVT
VAWKADSSPVKAGVETTTPSKQSNKKAASSYLSLTPEQWKSQRSYSCQV
THEGSTVEKTVAPTECS
>NI-0801 Heavy Chain Amino Acid Sequence
                                     (SEQ ID NO: 135)
QVQLVESGGGVVQPGSRSLRSLCAASGFTFSNSGIHWVRQAPGKGLEWVAV
ISYDGSNKYYADSVKGRFTISRDNKNTLYLQMNSLRAEDTAVYYCARLR
DNAEYTDYWGQGLTVTVSSASTKGPSVFPLAPSSKSTSGGTAALGCLVKD
YFPEPVTVSWNSGALTSGVHTFPAVLQSSGLYSLSSVTVTPSSSLGTQTY
ICNVNHKPSNTKVDKRVKPKSCDKTHTCPPCPAPELGGPSVFLFPPKPK
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-continued

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TYRVVSVLTVLHQDWLNGKEYKCKVSNKALPAPIEKTISKAKGQPREPQV
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DSDGSSFLLYSKLTVDKSRWQQGNVFCSCVMHEALHNHYTQKSLSLSPGK
```

Example 9

Inhibition of hIP-10-Induced Calcium Flux or Cell Chemotaxis Using Reformatted scFv into IgG1 Format

scFv were reformatted into an IgG format as described above in Example 8. The neutralizing potential of the IgG on hIP-10-induced calcium flux or cell chemotaxis was evaluated using the cell-based assays described in Example 6 and 8. As shown in FIGS. 1, 2 and 3 these IgG clones inhibit the activity of both recombinant and native hIP-10 in a dose-dependent manner. The IC_{50} values in these assays for each antibodies are summarized in Tables 5 and 6.

TABLE 5

Potency of antibodies tested in IgG1 format in chemotaxis and calcium flux functional assays.		
Clone ID	Chemotaxis IC_{50} (nM)	Calcium flux IC_{50} (nM)
NI-0801	0.24 §	6.3
Cf1N1R3P4_C7	0.19 §	4.1
Cf1H1R3P3_G11	0.2 §	7.9
Cf1H1R3P4_B5	0.42 §	4.7
Cf1A11R3P3_F3	0.69 §	5.9
CC21R3P1_F1	3	9.8
CB21R3P3_E5	122	ND
CC21R3P1_H6	75	>200
CB2R2P4_C3	33	>200
CC21R3P4_F4	157	>200
CC21R3P1_E7	56	>200
CC21R3P1_A2	3.2	9.8
CB21R3P6_G7	8.8	6.2

Chemotaxis was performed using either 1 nM, or 0.2 nM § of rhIP-10 while calcium flux was induced with 10 nM of rhIP-10. Antibodies in the top part of the table were obtained after affinity maturation.

TABLE 6

Potency of antibodies tested in IgG1 format in chemotaxis functional assay performed using native human IP-10 (hIP-10) at 0.6 nM.	
Clone ID	Chemotaxis IC_{50} (nM)
NI-0801	0.58
CF1N1R3P4_C7	0.64
CF1H1R3P3_G11	1.9
CF1H1R3P4_B5	1.2
CF1A11R3P3_F3	1.7
CC21R3P1_F1	11
CC21R3P1_A2	6.2
CB21R3P6_G7	7.8

Example 10

Antibody Binding to hIP-10 Immobilized on Glycosaminoglycan

As with many chemokines, hIP-10 is able to oligomerize and bind to glycosaminoglycans (GAG) expressed at surface of cells such as endothelial cells. In order to make sure that the antibodies were able to bind to hIP-10 in this context, they

were tested in the following assay. Maxisorb 96 well plates were coated with anti-human Fc (Jackson, West Grove, Pa.) as capturing reagent for the human IgG to be tested. FITC-labeled heparin (Sigma, St. Louis, Mo.) was used as a prototypic GAG and was incubated with hIP-10 before addition to the captured anti-hIP10 antibodies. Binding was revealed using an HRP-coupled anti-FITC Fab (Roche, Basel, Switzerland). As shown in FIG. 4 some antibodies were able to bind hIP-10 when bound to GAG whereas others were unable to do so probably because their epitope on hIP-10 was no longer accessible within the oligomeric structure. The capacity of the antibodies to bind hIP-10 in the context of GAG is summarized in Table 7.

TABLE 7

<u>Ability of antibodies to bind to hIP-10 immobilized on GAG.</u>	
Clone ID	Binding to hIP-10 on GAG
NI-0801	yes
CF1N1R3P4_C7	yes
CF1H1R3P3_G11	yes
CF1H1R3P4_B5	yes
CF1A11R3P3_F3	yes
CC21R3P1_F1	yes
CB21R3P3_E5	yes
CC21R3P1_H6	yes
CC21R3P1_A2	no
CB21R3P6_G7	no
CC21R3P4_F4	yes

Example 11

Affinity Maturation of Antibody CC_F1

The selected lead candidate (CC21R3P1_F1) was subjected to affinity maturation in order to increase its affinity for hIP-10 and its potency in hIP-10 neutralization assays. Stretches of 5 residues in the CDR3 of the heavy or light chain were randomized in order to generate 6 libraries (Library size ranging from 5×10^7 to 2×10^8). Three high stringency selection rounds were performed as described in Example 5. Screening for improved variant was performed using scFv periplasmic extracts in an epitope competition assay. Briefly, the parent antibody (CC21R3P1_F1) was coated on plates and diluted periplasmic scFv extracts were added to each well. Biotinylated hIP-10 was then added and incubated for 2 hours at room temperature. After washing, hIP-10 remaining bound to the coated parent antibody was revealed using streptavidin coupled HRP (Jackson, West Grove Pa.). As a reference to identify improved variants, CC21R3P1_F1 scFv was used to compete coated CC21R3P1_F1 in an IgG format. The clone CF1A11R3P3_F3 was identified as a more potent antibody in competition assays well as chemotaxis and calcium flux assays.

A second round of affinity maturation was performed on clone CF1A11R3P3_F3 by combining its heavy chain with light chains that were selected during the CC21R3P1_F1 affinity maturation process. This second round led to the identification of the clones CF1H1R3P4_B5 and CF1H1R3P3_G11. A third round of affinity maturation was performed on the heavy chain CDR3 of clone CF1H1R3P3_G11 and a further improved antibody variant, CF1N1R3P4_C7, was isolated. (Tables 4, 5 and 6)

In parallel a second candidate, CC21R3P1_E7, was also subjected to a similar affinity maturation process targeting the CDR3 of the light chain. In this process, the clone

CE7C1R3H8_J9 was isolated and was more potent in chemotaxis assays when compared to the parent antibody.

Example 12

Back-Mutation of hIP-10 Antibody Clone C7 to Germline Sequence

In the studies described herein, the nucleotides and amino acid residues in the nucleic acid and amino acid sequence of the CF1N1R3P4_C7 clone were mutated to correspond to the nucleotide or amino acid residue found in the germline sequence. This process is referred to herein as "back-mutation".

CF1N1R3P4_C7 heavy chain: The immunoglobulin heavy variable gene of antibody CF1N1R3P4_C7 had a 96% homology to the human germ line DP-49 or IGHV3-30 (GenBank Accession number M99663). CF1N1R3P4_C7 VH has 5 mutations compared to IGHV3-30, three in the CDR1, one in CDR2 and one in the framework four. The mutated amino acid residues are boxed in FIG. 5. The five mutations are: Ser to Asn at Kabat position 31; Tyr to Ser at Kabat position 32; Met to Ile at Kabat position 34; Tyr to Phe at Kabat position 58 and Arg to Lys at Kabat positions 94. All five amino acids of CF1N1R3P4_C7 VH were individually back mutated to their germline equivalent and the impact of the mutation on the antibody potency was evaluated in chemotaxis and calcium flux functional assays. A significant decrease in potency was observed for all changes in the CDR1 and therefore the amino acids found in CF1N1R3P4_C7 were left unchanged in the final NI-0801 sequence. The mutations in the CDR2 as well as at the end of the framework four did not alter the antibody potency and were therefore were introduced in the NI-0801 VH sequence. The immunoglobulin heavy joining (IGHJ) region of CF1N1R3P4_C7 was compared to the six human functional IGHJ regions. The IGHJ region of CF1N1R3P4_C7 was identified as IGHJ4 with a 100% homology outside the CDR3 encoding region.

CF1N1R3P4_C7 light chain. The immunoglobulin lambda variable gene (VL) of antibody CF1N1R3P4_C7 belongs to the IGLV6-57 or V1-22 subgroup (GenBank Accession Number Z73673). CF1N1R3P4_C7-VL has 4 mutations compared to IGLV6-57, all located in the CDR1. The mutated amino acid residues are shown in boxes in FIG. 5. The four mutations are: Arg to Gly at Kabat position 25; Ser to Gly at Kabat position 27; Ala to Asp and Ser to Arg at Kabat positions 29 and 30, respectively. The four mutations in the framework regions were changed pair wise (i.e. Gly25Arg/Gly27Ser and Asp29Ala/Arg30Ser). A significant decrease in potency was observed in Gly25Arg/Gly27Ser mutant and therefore the amino acids found in CF1N1R3P4_C7 at these positions were left unchanged. The mutations Asp29Ala/Arg30Ser did not alter the antibody potency and these two amino acids were mutated to their germline equivalents in the NI-0801 VL sequence.

The immunoglobulin heavy joining (IGLJ) region of CF1N1R3P4_C7 was compared to the seven human functional IGLJ regions. The IGLJ region of CF1N1R3P4_C7 was identified as IGL3J4 with a 100% homology outside the CDR3 encoding region.

Example 13

Affinity and Binding Kinetics of hIP-10 Antibodies

The affinity and binding kinetics of NI-0801 and CC21R3P1_F1 were characterized on a Biacore 2000 instru-

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ment (Biacore AB, Uppsala, Sweden). 200RU (response unit) of a goat anti-human polyclonal IgG (ahIgG; Biacore AB, Uppsala, Sweden) were immobilized by EDC/NHS chemistry on a C1 Biacore chip. This surface was used to capture NI-0801 or other human IgG1 that were characterized. The surface was regenerated after each cycle by injection of 10 mM glycine pH=1.5 at 30 μ L/min, for 30 s followed by 1 min. of stabilization time in HBS-EP buffer.

Binding was measured by passing either hIP-10 (Peprotech, Rocky Hill N.J.) or a NusA-hIP-10 fusion protein at the following concentrations: 34.7 nM, 11.6 nM, 3.85 nM, 1.28 nM, 0.428 nM, 0.142 nM and 0 nM. All solutions were diluted in HBS-EP buffer (Biacore AB, Uppsala, Sweden). Injection was performed at 50 μ L/min for 3 min. followed by 12 min. of dissociation time and the temperature was set at 25° C. The data was fitted according to 1:1 Langmuir model and the K_{on} , K_{off} and K_D values determined. Very similar values were obtained using rhIP-10 or the NusA-hIP-10 fusion, but better response signals were obtained with the fusion protein due to its larger size that induces a better response on the Biacore. The affinity of antibodies and CC21R3P1_F1 and NI-0801 for hIP-10 are 90.2 nM and 109 pM, respectively (FIG. 6). It appears therefore that during the affinity maturation process the affinity of CC21R3P1_F1 was improved 90-fold. The Affinities and kinetic constants of both antibodies are summarized in Table 8.

TABLE 8

Kinetic and affinity constants measured by Biacore.			
Clone ID	K_{on}	K_{off}	K_D (M)
CC21R3P1_F1	1.8×10^5	1.6×10^{-3}	9.2×10^{-9}
NI-0801	6.8×10^5	7.4×10^{-5}	1.09×10^{-10}

Example 14

Cross-Reactivity of hIP-10 Antibody

Binding assay: NI-0801 was tested for its ability to bind to IP-10 from different species using a capture ELISA format assay. Briefly, IP-10 cloned from cDNA isolated from mouse, rat, rabbit and cynomolgus as well as a panel of human chemokines was expressed and purified as described in Example 1. NI-0801 was coated and incubated with a concentration range of recombinant NusA fusion proteins. The level of binding was revealed using an anti-NusA antibody. As shown in FIG. 7, NI-0801 only cross reacts with cynomolgus IP-10 and not with IP-10 from other species nor with any of the other human chemokines tested.

Functional assays: Human ITAC and human MIG are chemokines that also signal via hCXCR3. NI-0801 was tested for its ability to neutralize these other hCXCR3 ligands in the chemotaxis assays described in Example 7. Recombinant

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hITAC, hMIG and hIP-10 (Peprotech) were all able to induce cells chemotaxis of hCXCR3 expressing L1.2 cells and NI-0801 was only able to neutralize the activity of hIP-10 (FIGS. 8A-8B). The neutralization potential of NI-0801 on IP-10 from different species was also assessed functionally. As shown in FIG. 9, recombinant human, mouse, rat and rabbit IP-10 are able to induce cell chemotaxis but only the activity of hIP-10 could be neutralized by a saturating dose of NI-0801 (50 μ g/ml).

Example 15

Epitope Mapping of hIP-10 Antibody

In an ELISA assay, NI-0801 binds with equivalent apparent affinity to both human and cynomolgus IP-10 (FIG. 7). In order to identify residues potentially required on hIP-10 for binding to NI-0801, we aligned the IP-10 protein sequences from several species as shown in FIG. 10. In the alignment, we looked for residues that are conserved between the human and cynomolgus sequences and that are different in IP-10 from species to which NI-0801 is unable to bind. The sequence of rabbit IP-10 is close to the human IP-10 sequence although NI-0801 is unable to neutralize that protein. We identified several residues that are different in rabbit IP-10 when compared to both human and cynomolgus IP-10: N13, K17, D48, L48, K63, F68, R74, G75 and S77. Four mutants of rabbit IP-10 were generated by site directed mutagenesis in order to restore the human residues at those positions: [N13S/K17Q]; [D48K]; [L48S/K63N/F68V] and [L48S/K63N/F68V/R74K/G75R/S77P]. These mutant forms of rabbit IP-10 were expressed as NusA fusion proteins as described in Example 1. We then tested whether the introduction of these residues could restore NI-0801 binding to rabbit IP-10 in an ELISA assay. NusA-hIP-10 as well as the different NusA-rabbit IP-10 mutants were coated in a Maxisorb plate (Nunc) at 5 μ g/ml over night at 4° C. After blocking with 3% PBS-BSA and incubation with a dose range of NI-0801 the plates were washed and incubated with a goat anti-human IgG Fc γ -specific antibody coupled to horse radish peroxidase (Jackson). After washing the signal was revealed with TMB (Roche) and stopped with H₂SO₄. The plates were read at 450 nm. As shown in FIG. 11, the [N13S/K17Q] mutant restores binding of NI-0801 to rabbit IP-10 indicating that S13 and Q17 are critical for the NI-0801 epitope integrity on human IP-10.

Other Embodiments

While the invention has been described in conjunction with the detailed description thereof, the foregoing description is intended to illustrate and not limit the scope of the invention, which is defined by the scope of the appended claims. Other aspects, advantages, and modifications are within the scope of the following claims.

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Gly Ile His Trp Val Arg Gln Ala Pro Gly Lys Gly Leu Glu Trp Val
35           40           45
Ala Val Ile Ser Tyr Asp Gly Ser Asn Lys Tyr Tyr Ala Asp Ser Val
50           55           60
Lys Gly Arg Phe Thr Ile Ser Arg Asp Asn Ser Lys Asn Thr Leu Tyr
65           70           75           80
Leu Gln Met Asn Ser Leu Arg Ala Glu Asp Thr Ala Val Tyr Tyr Cys
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ccgggcagtt cccccaccac tgtcatctat gaggataacc agagaccctc tggggtcctc      180
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 35 40 45

Ile Tyr Glu Asp Asn Gln Arg Pro Ser Gly Val Pro Asp Arg Phe Ser
 50 55 60

Gly Ser Ile Asp Ser Ser Ser Asn Ser Ala Ser Leu Thr Ile Ser Gly
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Leu Lys Thr Glu Asp Glu Ala Asp Tyr Tyr Cys Gln Ser Tyr Asp Pro
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 Ala Val Ile Ser Tyr Asp Gly Ser Asn Lys Phe Tyr Ala Asp Ser Val
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 Lys Gly Arg Phe Thr Ile Ser Arg Asp Asn Ser Lys Asn Thr Leu Tyr
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<220> FEATURE:
<223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 15

Val Ile Ser Tyr Asp Gly Ser Asn Lys Phe Tyr Ala Asp Ser Val Lys
1 5 10 15

Gly

<210> SEQ ID NO 16
<211> LENGTH: 13
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: chemically synthesized

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<400> SEQUENCE: 16

Thr Gly Ser Gly Gly Ser Ile Asp Arg Asn Tyr Val Gln
 1 5 10

<210> SEQ ID NO 17

<211> LENGTH: 357

<212> TYPE: DNA

<213> ORGANISM: Artificial Sequence

<220> FEATURE:

<223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 17

caggtgcagc tgggtggagtc tgggggaggc gtggtccagc ctgggaggtc cctgagactc 60
 tcctgtgcag cctctggatt caccttcagt aactctggca tacactgggt ccgccaggct 120
 ccaggcaagg gactggagtg ggtggcagtt atatcatatg atggaagtaa caaattctac 180
 gcagactccg tgaagggccg attcaccatc tccagagaca actccaagaa cactctgtat 240
 ctgcaaatga acagcctgag agctgaggac acggctgtct attattgtgc aaaattgagg 300
 gataatggtg agtacttaga ctactggggc caggaaccc tggtcaccgt ctcgagt 357

<210> SEQ ID NO 18

<211> LENGTH: 119

<212> TYPE: PRT

<213> ORGANISM: Artificial Sequence

<220> FEATURE:

<223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 18

Gln Val Gln Leu Val Glu Ser Gly Gly Gly Val Val Gln Pro Gly Arg
 1 5 10 15
 Ser Leu Arg Leu Ser Cys Ala Ala Ser Gly Phe Thr Phe Ser Asn Ser
 20 25 30
 Gly Ile His Trp Val Arg Gln Ala Pro Gly Lys Gly Leu Glu Trp Val
 35 40 45
 Ala Val Ile Ser Tyr Asp Gly Ser Asn Lys Phe Tyr Ala Asp Ser Val
 50 55 60
 Lys Gly Arg Phe Thr Ile Ser Arg Asp Asn Ser Lys Asn Thr Leu Tyr
 65 70 75 80
 Leu Gln Met Asn Ser Leu Arg Ala Glu Asp Thr Ala Val Tyr Tyr Cys
 85 90 95
 Ala Lys Leu Arg Asp Asn Gly Glu Tyr Leu Asp Tyr Trp Gly Gln Gly
 100 105 110
 Thr Leu Val Thr Val Ser Ser
 115

<210> SEQ ID NO 19

<211> LENGTH: 333

<212> TYPE: DNA

<213> ORGANISM: Artificial Sequence

<220> FEATURE:

<223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 19

aattttatgc tgactcagcc cactctgtg tcggagtctc cggggaagac ggtgaccatc 60
 tcctgcaccg gcagcgggtg cagcattgac agaaactatg tgcagtggta ccagcagcgc 120
 ccgggcagtt cccccaccac tgtgatctat gaggataacc aaagaccctc tgggggtcccg 180
 gatcgattct ctggtccat cgacagctcc tccaactctg cctccctcac catctctgga 240

-continued

ctaaaaactg aagacgagc tgactactac tgcagtcctt atgatccgct tccgggtgtgg 300
gttttcggcg gagggaccaa gctcaccgtc cta 333

<210> SEQ ID NO 20
<211> LENGTH: 98
<212> TYPE: PRT
<213> ORGANISM: Homo sapiens

<400> SEQUENCE: 20

Gln Val Gln Leu Val Glu Ser Gly Gly Gly Val Val Gln Pro Gly Arg
1 5 10 15
Ser Leu Arg Leu Ser Cys Ala Ala Ser Gly Phe Thr Phe Ser Ser Tyr
20 25 30
Gly Met His Trp Val Arg Gln Ala Pro Gly Lys Gly Leu Glu Trp Val
35 40 45
Ala Val Ile Ser Tyr Asp Gly Ser Asn Lys Tyr Tyr Ala Asp Ser Val
50 55 60
Lys Gly Arg Phe Thr Ile Ser Arg Asp Asn Ser Lys Asn Thr Leu Tyr
65 70 75 80
Leu Gln Met Asn Ser Leu Arg Ala Glu Asp Thr Ala Val Tyr Tyr Cys
85 90 95
Ala Arg

<210> SEQ ID NO 21
<211> LENGTH: 10
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 21

Leu Arg Asp Asn Gly Glu Tyr Leu Asp Tyr
1 5 10

<210> SEQ ID NO 22
<211> LENGTH: 334
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 22

aattttatgc tgactcagcc ccaactctgtg tcggagtctc cggggaagac ggtgaccatc 60
tctgcaccg gcagcgggtg cagcattgac agaaactatg tgcagtggta ccagcagcgc 120
ccgggcagtt cccccaccac tgtgatctat gaggataacc aaagaccctc tgggggtcccg 180
gatcgattct ctggctccat cgacagctcc tccaactctg cctccctcac catctctgga 240
ctaaaaactg aagacgagc tgactactac tgcagtcctt atgtggagac gcttgagtgg 300
gttttcggcg gagggaccaa gctcaccgtc ctg 334

<210> SEQ ID NO 23
<211> LENGTH: 111
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 23

Asn Phe Met Leu Thr Gln Pro His Ser Val Ser Glu Ser Pro Gly Lys
1 5 10 15

-continued

<213> ORGANISM: Artificial Sequence

<220> FEATURE:

<223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 30

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caggtgcagc tgggtgcagtt tgggggagggc gtggtccagc ctgggaggtc cttgagactc      60
tctctgtcag cctctggatt caccttcagt agctatggca tgcactgggt ccgccaggct      120
ccaggcaagg ggctggagtg ggtggcagtt atatcatatg atggaagtat taaatactat      180
gcagactccg tgaagggccg attcaccatc tccagagaaa atgccaagaa ctccgtgtat      240
ctgcaaatgg acagcctgag agtcggggac acggctgtgt attactgtac aagagccggg      300
tatagtactg actggcatcc cgactactgg ggccagggga caatggtcac cgtctcgagt      360

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<210> SEQ ID NO 31

<211> LENGTH: 120

<212> TYPE: PRT

<213> ORGANISM: Artificial Sequence

<220> FEATURE:

<223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 31

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Gln Val Gln Leu Val Gln Phe Gly Gly Gly Val Val Gln Pro Gly Arg
1           5           10           15
Ser Leu Arg Leu Ser Cys Ala Ala Ser Gly Phe Thr Phe Ser Ser Tyr
          20           25           30
Gly Met His Trp Val Arg Gln Ala Pro Gly Lys Gly Leu Glu Trp Val
          35           40           45
Ala Val Ile Ser Tyr Asp Gly Ser Ile Lys Tyr Tyr Ala Asp Ser Val
          50           55           60
Lys Gly Arg Phe Thr Ile Ser Arg Glu Asn Ala Lys Asn Ser Val Tyr
65           70           75           80
Leu Gln Met Asp Ser Leu Arg Val Gly Asp Thr Ala Val Tyr Tyr Cys
          85           90           95
Thr Arg Ala Gly Tyr Ser Thr Asp Trp His Pro Asp Tyr Trp Gly Gln
          100          105          110
Gly Thr Met Val Thr Val Ser Ser
          115          120

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<210> SEQ ID NO 32

<211> LENGTH: 324

<212> TYPE: DNA

<213> ORGANISM: Artificial Sequence

<220> FEATURE:

<223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 32

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tcttctgagc tgactcagga ccctgctgtg tctgtggcct tgggacagac agtcaggatc      60
acatgccaaag gagacagcct cagaagctat tatgcaagct ggtaccagca gaagccagga      120
caggccoctg tacttgccat ctatggtaaa aacaaccggc cctcagggat cccagaccga      180
ttctctggct ccagctcagg aaacacagct tccttgacca tcaactggggc tcaggcggaa      240
gatgaggctg actattactg taactcccgg gacagcagtg gtaaccatgt ggtattcggc      300
ggagggacca agctgaccgt ccta                                     324

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<210> SEQ ID NO 33

<211> LENGTH: 108

<212> TYPE: PRT

<213> ORGANISM: Artificial Sequence

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<220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 33

Ser Ser Glu Leu Thr Gln Asp Pro Ala Val Ser Val Ala Leu Gly Gln
 1 5 10 15
 Thr Val Arg Ile Thr Cys Gln Gly Asp Ser Leu Arg Ser Tyr Tyr Ala
 20 25 30
 Ser Trp Tyr Gln Gln Lys Pro Gly Gln Ala Pro Val Leu Ala Ile Tyr
 35 40 45
 Gly Lys Asn Asn Arg Pro Ser Gly Ile Pro Asp Arg Phe Ser Gly Ser
 50 55 60
 Ser Ser Gly Asn Thr Ala Ser Leu Thr Ile Thr Gly Ala Gln Ala Glu
 65 70 75 80
 Asp Glu Ala Asp Tyr Tyr Cys Asn Ser Arg Asp Ser Ser Gly Asn His
 85 90 95
 Val Val Phe Gly Gly Gly Thr Lys Leu Thr Val Leu
 100 105

<210> SEQ ID NO 34
 <211> LENGTH: 5
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 34

Ser Tyr Gly Met His
 1 5

<210> SEQ ID NO 35
 <211> LENGTH: 17
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 35

Val Ile Ser Tyr Asp Gly Ser Ile Lys Tyr Tyr Ala Asp Ser Val Lys
 1 5 10 15

Gly

<210> SEQ ID NO 36
 <211> LENGTH: 11
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 36

Ala Gly Tyr Ser Thr Asp Trp His Pro Asp Tyr
 1 5 10

<210> SEQ ID NO 37
 <211> LENGTH: 11
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 37

Gln Gly Asp Ser Leu Arg Ser Tyr Tyr Ala Ser
 1 5 10

-continued

<210> SEQ ID NO 38
 <211> LENGTH: 7
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 38

Gly Lys Asn Asn Arg Pro Ser
 1 5

<210> SEQ ID NO 39
 <211> LENGTH: 11
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 39

Asn Ser Arg Asp Ser Ser Gly Asn His Val Val
 1 5 10

<210> SEQ ID NO 40
 <211> LENGTH: 366
 <212> TYPE: DNA
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 40

caggtcacct tgagggagtc tggctctgcg ctggtgaaac ccacacagac cctcacactg 60
 acctgcacct tctctggatt ctcactcacc actagtggaa tgtctgtgat ttggatccgt 120
 cagccccag ggaaggcct ggagtggctt gcacgcattg attcggatga cgagaaacac 180
 tacaacacat ctctgaagac caggctcgcc atctccaagg acacctcaa aaaccaggtg 240
 gtccttaciaa tgaccaacat ggaccctgtg gacacaggca cctattactg tgcacggctt 300
 cgggctgggtt caggtccata tgtttttgac tcttgggggc aaggaccac ggtcaccgtc 360
 tcgagt 366

<210> SEQ ID NO 41
 <211> LENGTH: 122
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 41

Gln Val Thr Leu Arg Glu Ser Gly Pro Ala Leu Val Lys Pro Thr Gln
 1 5 10 15
 Thr Leu Thr Leu Thr Cys Thr Phe Ser Gly Phe Ser Leu Thr Thr Ser
 20 25 30
 Gly Met Ser Val Ile Trp Ile Arg Gln Pro Pro Gly Lys Ala Leu Glu
 35 40 45
 Trp Leu Ala Arg Ile Asp Ser Asp Asp Glu Lys His Tyr Asn Thr Ser
 50 55 60
 Leu Lys Thr Arg Leu Ala Ile Ser Lys Asp Thr Ser Lys Asn Gln Val
 65 70 75 80
 Val Leu Thr Met Thr Asn Met Asp Pro Val Asp Thr Gly Thr Tyr Tyr
 85 90 95

-continued

Cys Ala Arg Leu Arg Ala Gly Ser Gly Pro Tyr Val Phe Asp Ser Trp
 100 105 110

Gly Gln Gly Thr Thr Val Thr Val Ser Ser
 115 120

<210> SEQ ID NO 42
 <211> LENGTH: 331
 <212> TYPE: DNA
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 42

cagtctgtgc tgactcagcc accctcagcg tctgggaccc ccgggcagag ggtcaccatc 60
 tcttggtctg gaagcagctc caacatcggg agtaacactg taaactggta ccagcgactc 120
 ccaggagcgg ccccccaact cctcatctac aataatgacc agcggccctc agggatccct 180
 gaccgattct ctggctccaa gtctggcacc tcaggctccc tggtcacag tgggctccag 240
 tctgaagacg aggctgatta ctactgtgcg tcatgggatg acagtctgaa tggtcgggtg 300
 ttcggcggag ggaccaagct gaccgtccta g 331

<210> SEQ ID NO 43
 <211> LENGTH: 110
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 43

Gln Ser Val Leu Thr Gln Pro Pro Ser Ala Ser Gly Thr Pro Gly Gln
 1 5 10 15
 Arg Val Thr Ile Ser Cys Ser Gly Ser Ser Ser Asn Ile Gly Ser Asn
 20 25 30
 Thr Val Asn Trp Tyr Gln Arg Leu Pro Gly Ala Ala Pro Gln Leu Leu
 35 40 45
 Ile Tyr Asn Asn Asp Gln Arg Pro Ser Gly Ile Pro Asp Arg Phe Ser
 50 55 60
 Gly Ser Lys Ser Gly Thr Ser Gly Ser Leu Val Ile Ser Gly Leu Gln
 65 70 75 80
 Ser Glu Asp Glu Ala Asp Tyr Tyr Cys Ala Ser Trp Asp Asp Ser Leu
 85 90 95
 Asn Gly Arg Val Phe Gly Gly Gly Thr Lys Leu Thr Val Leu
 100 105 110

<210> SEQ ID NO 44
 <211> LENGTH: 7
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 44

Thr Ser Gly Met Ser Val Ile
 1 5

<210> SEQ ID NO 45
 <211> LENGTH: 16
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

-continued

<400> SEQUENCE: 45

Arg Ile Asp Ser Asp Asp Glu Lys His Tyr Asn Thr Ser Leu Lys Thr
 1 5 10 15

<210> SEQ ID NO 46

<211> LENGTH: 12

<212> TYPE: PRT

<213> ORGANISM: Artificial Sequence

<220> FEATURE:

<223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 46

Leu Arg Ala Gly Ser Gly Pro Tyr Val Phe Asp Ser
 1 5 10

<210> SEQ ID NO 47

<211> LENGTH: 13

<212> TYPE: PRT

<213> ORGANISM: Artificial Sequence

<220> FEATURE:

<223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 47

Ser Gly Ser Ser Ser Asn Ile Gly Ser Asn Thr Val Asn
 1 5 10

<210> SEQ ID NO 48

<211> LENGTH: 7

<212> TYPE: PRT

<213> ORGANISM: Artificial Sequence

<220> FEATURE:

<223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 48

Asn Asn Asp Gln Arg Pro Ser
 1 5

<210> SEQ ID NO 49

<211> LENGTH: 11

<212> TYPE: PRT

<213> ORGANISM: Artificial Sequence

<220> FEATURE:

<223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 49

Ala Ser Trp Asp Asp Ser Leu Asn Gly Arg Val
 1 5 10

<210> SEQ ID NO 50

<211> LENGTH: 369

<212> TYPE: DNA

<213> ORGANISM: Artificial Sequence

<220> FEATURE:

<223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 50

caggtgcagc tgggtggagtc tgggggaggc gtggtccggc ctgggaggtc cctgagactc 60
 tcctgtgcag cctctggatt caccttcagt agctatggca tgcactgggt ccgccaggct 120
 ccaggcaagg ggctggagtg ggtggcagtt atatcatatg atggaagtat taaatactat 180
 gcagactccg tgaagggccg attcaccatc tccagagaca attccaagaa cacgctgtat 240
 ctgcaaatga acagcctgag agctgaggac acggccattht attactgtgc gagagtgatg 300
 gggacggatc cccactccta ctactacatg gacgtctggg ggaaggggac cctggtcacc 360

-continued

gtctcgagt

369

<210> SEQ ID NO 51
 <211> LENGTH: 123
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 51

Gln Val Gln Leu Val Glu Ser Gly Gly Gly Val Val Arg Pro Gly Arg
 1 5 10 15
 Ser Leu Arg Leu Ser Cys Ala Ala Ser Gly Phe Thr Phe Ser Ser Tyr
 20 25 30
 Gly Met His Trp Val Arg Gln Ala Pro Gly Lys Gly Leu Glu Trp Val
 35 40 45
 Ala Val Ile Ser Tyr Asp Gly Ser Ile Lys Tyr Tyr Ala Asp Ser Val
 50 55 60
 Lys Gly Arg Phe Thr Ile Ser Arg Asp Asn Ser Lys Asn Thr Leu Tyr
 65 70 75 80
 Leu Gln Met Asn Ser Leu Arg Ala Glu Asp Thr Ala Ile Tyr Tyr Cys
 85 90 95
 Ala Arg Val Met Gly Thr Asp Pro His Ser Tyr Tyr Tyr Met Asp Val
 100 105 110
 Trp Gly Lys Gly Thr Leu Val Thr Val Ser Ser
 115 120

<210> SEQ ID NO 52
 <211> LENGTH: 14
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 52

Val Met Gly Thr Asp Pro His Ser Tyr Tyr Tyr Met Asp Val
 1 5 10

<210> SEQ ID NO 53
 <211> LENGTH: 354
 <212> TYPE: DNA
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 53

caggtgcagc tgggtggagtc tgggggaggc gtggtccagc ctgggaggtc cctgagactc 60
 tcctgtgcag cctctggatt caccttcagt agctatggca tgcactgggt ccgccaggct 120
 ccaggcaagg ggctggagtg ggtggcagtt atatcatatg atggaagtat taaatactat 180
 gcagactccg tgaagggccg attcaccatc tccagagaca attccaagaa cacgctgtat 240
 ctgcaaatga acagcctgag agctgaggac gcggctgtgt attactgtgc gagagcacca 300
 gatggccacc aacttgacta ctggggcagg ggcaccctgg tcaccgtctc gagt 354

<210> SEQ ID NO 54
 <211> LENGTH: 118
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

-continued

<400> SEQUENCE: 54

Gln Val Gln Leu Val Glu Ser Gly Gly Gly Val Val Gln Pro Gly Arg
 1 5 10 15
 Ser Leu Arg Leu Ser Cys Ala Ala Ser Gly Phe Thr Phe Ser Ser Tyr
 20 25 30
 Gly Met His Trp Val Arg Gln Ala Pro Gly Lys Gly Leu Glu Trp Val
 35 40 45
 Ala Val Ile Ser Tyr Asp Gly Ser Ile Lys Tyr Tyr Ala Asp Ser Val
 50 55 60
 Lys Gly Arg Phe Thr Ile Ser Arg Asp Asn Ser Lys Asn Thr Leu Tyr
 65 70 75 80
 Leu Gln Met Asn Ser Leu Arg Ala Glu Asp Ala Ala Val Tyr Tyr Cys
 85 90 95
 Ala Arg Ala Pro Asp Gly His Gln Leu Asp Tyr Trp Gly Arg Gly Thr
 100 105 110
 Leu Val Thr Val Ser Ser
 115

<210> SEQ ID NO 55

<211> LENGTH: 330

<212> TYPE: DNA

<213> ORGANISM: Artificial Sequence

<220> FEATURE:

<223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 55

aattttatgc tgactcagcc ccactctgtg tcggagtctc cggggaagac ggtaaccatc 60
 tcctgcaccg gcagcagtg cagcattgcc agcaactatg tgcagtggta ccagcagcgc 120
 ccgggcagtg cccccaccac tgtgatctat gaagatgacc aaagaccctc tgacgtcctt 180
 gatcgcttct ctggctccat cgacagctcc tccaactctg cctccctcac catctctgga 240
 ctgaggactg aggacgagc tgactactac tgcagctctt atgtagcag caagtgggtg 300
 ttcggcggag ggaccaagct gaccgtccta 330

<210> SEQ ID NO 56

<211> LENGTH: 110

<212> TYPE: PRT

<213> ORGANISM: Artificial Sequence

<220> FEATURE:

<223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 56

Asn Phe Met Leu Thr Gln Pro His Ser Val Ser Glu Ser Pro Gly Lys
 1 5 10 15
 Thr Val Thr Ile Ser Cys Thr Gly Ser Ser Gly Ser Ile Ala Ser Asn
 20 25 30
 Tyr Val Gln Trp Tyr Gln Gln Arg Pro Gly Ser Ala Pro Thr Thr Val
 35 40 45
 Ile Tyr Glu Asp Asp Gln Arg Pro Ser Asp Val Pro Asp Arg Phe Ser
 50 55 60
 Gly Ser Ile Asp Ser Ser Ser Asn Ser Ala Ser Leu Thr Ile Ser Gly
 65 70 75 80
 Leu Arg Thr Glu Asp Glu Ala Asp Tyr Tyr Cys Gln Ser Tyr Val Ser
 85 90 95
 Ser Lys Trp Val Phe Gly Gly Gly Thr Lys Leu Thr Val Leu
 100 105 110

-continued

<210> SEQ ID NO 57
 <211> LENGTH: 9
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 57

Ala Pro Asp Gly His Gln Leu Asp Tyr
 1 5

<210> SEQ ID NO 58
 <211> LENGTH: 7
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 58

Glu Asp Asp Gln Arg Pro Ser
 1 5

<210> SEQ ID NO 59
 <211> LENGTH: 9
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 59

Gln Ser Tyr Val Ser Ser Lys Trp Val
 1 5

<210> SEQ ID NO 60
 <211> LENGTH: 402
 <212> TYPE: DNA
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 60

caggtgcagc tgggtgcagtc tggggctgag gtgaagaagc ctgggtcctc ggtgacggtc 60
 tcctgcaagg cctctggagg caccttcagc agcttttcta tcacctggct gcgacaggcc 120
 cctggacaag ggcttgagtg gatgggagag atcaccccta tgtttggtat agcaaactac 180
 gcacagaagt tccaggtag ggtcacgatt agcgcggacg agtccacgag cacagcctac 240
 atggagttga gtggcctgac atctgaagac acggccatgt attattgtgc gagagatggt 300
 cggtttgatg tttccgatct tttgactgac aaacccaaag taacgataaa ctacaacggg 360
 atggacgtct ggggccaagg caccctggtc accgtctcga gt 402

<210> SEQ ID NO 61
 <211> LENGTH: 134
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 61

Gln Val Gln Leu Val Gln Ser Gly Ala Glu Val Lys Lys Pro Gly Ser
 1 5 10 15

Ser Val Thr Val Ser Cys Lys Ala Ser Gly Gly Thr Phe Ser Ser Phe
 20 25 30

-continued

Ser Ile Thr Trp Leu Arg Gln Ala Pro Gly Gln Gly Leu Glu Trp Met
 35 40 45

Gly Glu Ile Thr Pro Met Phe Gly Ile Ala Asn Tyr Ala Gln Lys Phe
 50 55 60

Gln Gly Arg Val Thr Ile Ser Ala Asp Glu Ser Thr Ser Thr Ala Tyr
 65 70 75 80

Met Glu Leu Ser Gly Leu Thr Ser Glu Asp Thr Ala Met Tyr Tyr Cys
 85 90 95

Ala Arg Asp Gly Arg Phe Asp Val Ser Asp Leu Leu Thr Asp Lys Pro
 100 105 110

Lys Val Thr Ile Asn Tyr Asn Gly Met Asp Val Trp Gly Gln Gly Thr
 115 120 125

Leu Val Thr Val Ser Ser
 130

<210> SEQ ID NO 62
 <211> LENGTH: 330
 <212> TYPE: DNA
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 62

cagtctgtgc tgactcagcc accctcagcg tctgggaccc ccgggcagag ggtcaccatc 60
 tcttgttctg gaagcagctc caacatcggg agtaacactg taaactggta ccagcgactc 120
 ccaggagcgg ccccccaact cctcatctac aataatgacc agcggcctc agggatccct 180
 gaccgattct ctggctcaa gtctggcacc tcaggctccc tggatcatcag tgggctccag 240
 tctgaagatg aggctgatta ctactgtgcg tcatgggatg acagtctgaa tggtcgggtg 300
 ttcggcggag ggaccaagct gaccgtccta 330

<210> SEQ ID NO 63
 <211> LENGTH: 110
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 63

Gln Ser Val Leu Thr Gln Pro Pro Ser Ala Ser Gly Thr Pro Gly Gln
 1 5 10 15

Arg Val Thr Ile Ser Cys Ser Gly Ser Ser Ser Asn Ile Gly Ser Asn
 20 25 30

Thr Val Asn Trp Tyr Gln Arg Leu Pro Gly Ala Ala Pro Gln Leu Leu
 35 40 45

Ile Tyr Asn Asn Asp Gln Arg Pro Ser Gly Ile Pro Asp Arg Phe Ser
 50 55 60

Gly Ser Lys Ser Gly Thr Ser Gly Ser Leu Val Ile Ser Gly Leu Gln
 65 70 75 80

Ser Glu Asp Glu Ala Asp Tyr Tyr Cys Ala Ser Trp Asp Asp Ser Leu
 85 90 95

Asn Gly Arg Val Phe Gly Gly Gly Thr Lys Leu Thr Val Leu
 100 105 110

<210> SEQ ID NO 64
 <211> LENGTH: 5
 <212> TYPE: PRT

-continued

<213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 64

Ser Phe Ser Ile Thr
 1 5

<210> SEQ ID NO 65
 <211> LENGTH: 17
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 65

Glu Ile Thr Pro Met Phe Gly Ile Ala Asn Tyr Ala Gln Lys Phe Gln
 1 5 10 15

Gly

<210> SEQ ID NO 66
 <211> LENGTH: 25
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 66

Asp Gly Arg Phe Asp Val Ser Asp Leu Leu Thr Asp Lys Pro Lys Val
 1 5 10 15

Thr Ile Asn Tyr Asn Gly Met Asp Val
 20 25

<210> SEQ ID NO 67
 <211> LENGTH: 378
 <212> TYPE: DNA
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 67

cagctggtgg agtctggagg aggcttgatc cagcctgggg ggtccctgag actttctctgt 60
 gcagcctctg gattcagcgt cagtgacacc tacatgaact ggggccgcca ggctccaggg 120
 aagggcctgg agtgggtgtc aagtatttat agcgatgata gcacatacta cgcagactcc 180
 gtgaagggca gattcaccat ctccagagac aattccaaga acacgctgtt tcttcaaata 240
 aacagtttga gagccgagga cacggctgtc tattactgtg cgagagataa ggagtatgta 300
 acatcaactg ggggcgccta ctactacttc tactacatgg acgtctgggg ccagggcacc 360
 ctggtcaccg tctcgagt 378

<210> SEQ ID NO 68
 <211> LENGTH: 126
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 68

Gln Leu Val Glu Ser Gly Gly Gly Leu Ile Gln Pro Gly Gly Ser Leu
 1 5 10 15

Arg Leu Ser Cys Ala Ala Ser Gly Phe Ser Val Ser Asp Thr Tyr Met
 20 25 30

-continued

Asn Trp Val Arg Gln Ala Pro Gly Lys Gly Leu Glu Trp Val Ser Ser
 35 40 45

Ile Tyr Ser Asp Asp Ser Thr Tyr Tyr Ala Asp Ser Val Lys Gly Arg
 50 55 60

Phe Thr Ile Ser Arg Asp Asn Ser Lys Asn Thr Leu Phe Leu Gln Ile
 65 70 75 80

Asn Ser Leu Arg Ala Glu Asp Thr Ala Val Tyr Tyr Cys Ala Arg Asp
 85 90 95

Lys Glu Tyr Val Thr Ser Thr Gly Gly Ala Tyr Tyr Tyr Phe Tyr Tyr
 100 105 110

Met Asp Val Trp Gly Gln Gly Thr Leu Val Thr Val Ser Ser
 115 120 125

<210> SEQ ID NO 69
 <211> LENGTH: 330
 <212> TYPE: DNA
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 69

cagtctgtgc tgactcagcc accctcagcg tctgggaccc ccgggcagag agtctccatc 60
 tcctgttctg gaagcagctc caacatcgga agtgatactg tgaactggta ccagcacctc 120
 ccaggaacgg cccccaaact cctcatctat aataataatc agcggccctc aggggtccct 180
 gaccgattct ctggctccaa gtctggcacc tcagcctccc tggccatcag tgggctccag 240
 tctgaggatg aggctgatta ttactgtgcc gcatgggatg acagcctgaa tggctctggta 300
 ttcggcggag ggaccaaggt caccgtccta 330

<210> SEQ ID NO 70
 <211> LENGTH: 110
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 70

Gln Ser Val Leu Thr Gln Pro Pro Ser Ala Ser Gly Thr Pro Gly Gln
 1 5 10 15

Arg Val Ser Ile Ser Cys Ser Gly Ser Ser Ser Asn Ile Gly Ser Asp
 20 25 30

Thr Val Asn Trp Tyr Gln His Leu Pro Gly Thr Ala Pro Lys Leu Leu
 35 40 45

Ile Tyr Asn Asn Asn Gln Arg Pro Ser Gly Val Pro Asp Arg Phe Ser
 50 55 60

Gly Ser Lys Ser Gly Thr Ser Ala Ser Leu Ala Ile Ser Gly Leu Gln
 65 70 75 80

Ser Glu Asp Glu Ala Asp Tyr Tyr Cys Ala Ala Trp Asp Asp Ser Leu
 85 90 95

Asn Gly Leu Val Phe Gly Gly Gly Thr Lys Val Thr Val Leu
 100 105 110

<210> SEQ ID NO 71
 <211> LENGTH: 13
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

-continued

<400> SEQUENCE: 71

Ser Gly Ser Ser Ser Asn Ile Gly Ser Asp Thr Val Asn
 1 5 10

<210> SEQ ID NO 72

<211> LENGTH: 7

<212> TYPE: PRT

<213> ORGANISM: Artificial Sequence

<220> FEATURE:

<223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 72

Asn Asn Asn Gln Arg Pro Ser
 1 5

<210> SEQ ID NO 73

<211> LENGTH: 11

<212> TYPE: PRT

<213> ORGANISM: Artificial Sequence

<220> FEATURE:

<223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 73

Ala Ala Trp Asp Asp Ser Leu Asn Gly Leu Val
 1 5 10

<210> SEQ ID NO 74

<211> LENGTH: 351

<212> TYPE: DNA

<213> ORGANISM: Artificial Sequence

<220> FEATURE:

<223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 74

caggtgcagc tgggtggagtc tgggggaggc gtggtccagc ctgggaggtc cctgagactc 60
 tcctgtgcag cctctggatt caccttcagt agctatggca tgcactgggt ccgccaggct 120
 ccaggcaagg ggctggagtg ggtggcagtt atatcatatg atggaagtaa taaatactat 180
 gcagactccg tgaagggccg attcaccatc tccagagaca attccaagaa cacgctgtat 240
 ctgcaaatga acagcctgag agctgaggac acggctgtgt attactgtgc gaaagacgag 300
 ttgatgctt ttgatatctg gggccgaggg acaatgggtca ccgtctcgag t 351

<210> SEQ ID NO 75

<211> LENGTH: 117

<212> TYPE: PRT

<213> ORGANISM: Artificial Sequence

<220> FEATURE:

<223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 75

Gln Val Gln Leu Val Glu Ser Gly Gly Gly Val Val Gln Pro Gly Arg
 1 5 10 15
 Ser Leu Arg Leu Ser Cys Ala Ala Ser Gly Phe Thr Phe Ser Ser Tyr
 20 25 30
 Gly Met His Trp Val Arg Gln Ala Pro Gly Lys Gly Leu Glu Trp Val
 35 40 45
 Ala Val Ile Ser Tyr Asp Gly Ser Asn Lys Tyr Tyr Ala Asp Ser Val
 50 55 60
 Lys Gly Arg Phe Thr Ile Ser Arg Asp Asn Ser Lys Asn Thr Leu Tyr
 65 70 75 80

-continued

Leu Gln Met Asn Ser Leu Arg Ala Glu Asp Thr Ala Val Tyr Tyr Cys
 85 90 95

Ala Lys Asp Glu Phe Asp Ala Phe Asp Ile Trp Gly Arg Gly Thr Met
 100 105 110

Val Thr Val Ser Ser
 115

<210> SEQ ID NO 76
 <211> LENGTH: 324
 <212> TYPE: DNA
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 76

tcctatgtgc tgactcagcc cccctcagtg tcggtggccc caggaacgac ggccaggatt 60
 acctgtgggg gaaacaatat cggaagtagg agtgtgcatt ggtaccagca gaagccaggc 120
 caggccctc tactggtcat ctattatgat agtgaccggc cctcagggat ccctctgcca 180
 ttctctggct ccaactctgg aaacacggcc accctgacca tcagtagggt cgaagccggg 240
 gatgaggccg actattactg tcaggtgtgg gatactagta gtggtcatta tgtcttcgga 300
 actgggacca aggtcacctg ccta 324

<210> SEQ ID NO 77
 <211> LENGTH: 108
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 77

Ser Tyr Val Leu Thr Gln Pro Pro Ser Val Ser Val Ala Pro Gly Thr
 1 5 10 15

Thr Ala Arg Ile Thr Cys Gly Gly Asn Asn Ile Gly Ser Arg Ser Val
 20 25 30

His Trp Tyr Gln Gln Lys Pro Gly Gln Ala Pro Leu Leu Val Ile Tyr
 35 40 45

Tyr Asp Ser Asp Arg Pro Ser Gly Ile Pro Leu Arg Phe Ser Gly Ser
 50 55 60

Asn Ser Gly Asn Thr Ala Thr Leu Thr Ile Ser Arg Val Glu Ala Gly
 65 70 75 80

Asp Glu Ala Asp Tyr Tyr Cys Gln Val Trp Asp Thr Ser Ser Gly His
 85 90 95

Tyr Val Phe Gly Thr Gly Thr Lys Val Thr Val Leu
 100 105

<210> SEQ ID NO 78
 <211> LENGTH: 8
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 78

Asp Glu Phe Asp Ala Phe Asp Ile
 1 5

<210> SEQ ID NO 79
 <211> LENGTH: 11
 <212> TYPE: PRT

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<213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 79

Gly Gly Asn Asn Ile Gly Ser Arg Ser Val His
 1 5 10

<210> SEQ ID NO 80
 <211> LENGTH: 7
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 80

Tyr Asp Ser Asp Arg Pro Ser
 1 5

<210> SEQ ID NO 81
 <211> LENGTH: 11
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 81

Gln Val Trp Asp Thr Ser Ser Gly His Tyr Val
 1 5 10

<210> SEQ ID NO 82
 <211> LENGTH: 354
 <212> TYPE: DNA
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 82

cagctggtgg agtctggggg aggcgtggtc cagcctggga ggtccctgag actctctctgt 60
 gcagcctctg gattcacctt cagtacctat ggcatgcact gggtcgcca ggctccaggc 120
 aaggggctgg agtgggtggc agttatatca tatgatggag gtactaaata ctatgcagac 180
 tccgtgaagg gccgattcac catctccaga gacaattcca tgaaaacgct ctatctgcaa 240
 atgaacagcc tgagaactga ggacacggct gtgtattact gtgcgaaaga tctggggggac 300
 ctacccccgg gccttgacta ctggggccag gggacaatgg tcaccgtctc gagt 354

<210> SEQ ID NO 83
 <211> LENGTH: 118
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 83

Gln Leu Val Glu Ser Gly Gly Gly Val Val Gln Pro Gly Arg Ser Leu
 1 5 10 15

Arg Leu Ser Cys Ala Ala Ser Gly Phe Thr Phe Ser Thr Tyr Gly Met
 20 25 30

His Trp Val Arg Gln Ala Pro Gly Lys Gly Leu Glu Trp Val Ala Val
 35 40 45

Ile Ser Tyr Asp Gly Gly Thr Lys Tyr Tyr Ala Asp Ser Val Lys Gly
 50 55 60

-continued

Arg Phe Thr Ile Ser Arg Asp Asn Ser Met Lys Thr Leu Tyr Leu Gln
65 70 75 80

Met Asn Ser Leu Arg Thr Glu Asp Thr Ala Val Tyr Tyr Cys Ala Lys
85 90 95

Asp Leu Gly Asp Leu Pro Pro Gly Leu Asp Tyr Trp Gly Gln Gly Thr
100 105 110

Met Val Thr Val Ser Ser
115

<210> SEQ ID NO 84
<211> LENGTH: 333
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 84

cagtctgtgc tgactcagcc accctcagcg tctgggaccc ccgggcagag ggtcaccatc 60
tcttgttctg gaagcagctc caacatcgga agtaatactg taaactggta ccagcagctc 120
ccaggagcgg cccccaaact cctcatctat actaataatc agcggcctc aggggtcctc 180
gaccgattct ctggctccaa gtctggcacc tcagcctccc tggccatcag tgggctccag 240
tctgaggatg aggctgatta ttactgtgca gcatgggatg acagcctgaa tggtaatgtg 300
gtattcggcg gagggaccaa ggtcaccgtc cta 333

<210> SEQ ID NO 85
<211> LENGTH: 111
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 85

Gln Ser Val Leu Thr Gln Pro Pro Ser Ala Ser Gly Thr Pro Gly Gln
1 5 10 15

Arg Val Thr Ile Ser Cys Ser Gly Ser Ser Ser Asn Ile Gly Ser Asn
20 25 30

Thr Val Asn Trp Tyr Gln Gln Leu Pro Gly Ala Ala Pro Lys Leu Leu
35 40 45

Ile Tyr Thr Asn Asn Gln Arg Pro Ser Gly Val Pro Asp Arg Phe Ser
50 55 60

Gly Ser Lys Ser Gly Thr Ser Ala Ser Leu Ala Ile Ser Gly Leu Gln
65 70 75 80

Ser Glu Asp Glu Ala Asp Tyr Tyr Cys Ala Ala Trp Asp Asp Ser Leu
85 90 95

Asn Gly Asn Val Val Phe Gly Gly Gly Thr Lys Val Thr Val Leu
100 105 110

<210> SEQ ID NO 86
<211> LENGTH: 5
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 86

Thr Tyr Gly Met His
1 5

-continued

<210> SEQ ID NO 87
 <211> LENGTH: 17
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 87

Val Ile Ser Tyr Asp Gly Gly Thr Lys Tyr Tyr Ala Asp Ser Val Lys
 1 5 10 15

Gly

<210> SEQ ID NO 88
 <211> LENGTH: 11
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 88

Asp Leu Gly Asp Leu Pro Pro Gly Leu Asp Tyr
 1 5 10

<210> SEQ ID NO 89
 <211> LENGTH: 7
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 89

Thr Asn Asn Gln Arg Pro Ser
 1 5

<210> SEQ ID NO 90
 <211> LENGTH: 12
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 90

Ala Ala Trp Asp Asp Ser Leu Asn Gly Asn Val Val
 1 5 10

<210> SEQ ID NO 91
 <211> LENGTH: 351
 <212> TYPE: DNA
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 91

cagggtgcagc tgggtggagtc tggggggaggc gtggctcagt ctgggaagtc cctgagactc 60
 tcctgtgcag cctctggatt caccttcagt aactatggca tgcactgggt ccgccaggct 120
 ccaggcaagg ggctggagtg gctggcagtc atatcatatg atggaagtaa cagatactat 180
 gcagactccg tgaagggccg attcaccatc tccagagaca attccaaca cacactgaat 240
 ctgcaaatga gcagcctgag agctgaggac acggctctat attactgtgc gaaagatgcc 300
 gggggggccgc ttgattactg gggcaagggc accctgggtca ccgtctcgag t 351

<210> SEQ ID NO 92
 <211> LENGTH: 117
 <212> TYPE: PRT

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<213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 92

Gln Val Gln Leu Val Glu Ser Gly Gly Gly Val Ala Gln Ser Gly Lys
 1 5 10 15
 Ser Leu Arg Leu Ser Cys Ala Ala Ser Gly Phe Thr Phe Ser Asn Tyr
 20 25 30
 Gly Met His Trp Val Arg Gln Ala Pro Gly Lys Gly Leu Glu Trp Leu
 35 40 45
 Ala Val Ile Ser Tyr Asp Gly Ser Asn Arg Tyr Tyr Ala Asp Ser Val
 50 55 60
 Lys Gly Arg Phe Thr Ile Ser Arg Asp Asn Ser Asn Asn Thr Leu Asn
 65 70 75 80
 Leu Gln Met Ser Ser Leu Arg Ala Glu Asp Thr Ala Leu Tyr Tyr Cys
 85 90 95
 Ala Lys Asp Ala Gly Gly Pro Leu Asp Tyr Trp Gly Lys Gly Thr Leu
 100 105 110
 Val Thr Val Ser Ser
 115

<210> SEQ ID NO 93
 <211> LENGTH: 337
 <212> TYPE: DNA
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 93

cagtctgtgc tgactcagct gactcagcca cctcgggtgt cactggcccc aggacagacg 60
 gccaccatta cttgtggggg agacaacatt ggacgtaaaa gtgtgcactg gtaccagcag 120
 aagccaggcc aggccctgt gttggtcgtc tatgatgaca ccgaccggcc ctcagggatc 180
 cctgagcgat tctctggctc caactctggg aacacggcca ccctaaccat cagcagggtc 240
 gaagccgggg atgaggccga ctattactgt caggtgtggg atagtagtat tgatcattct 300
 tgggtgttcg gcgaggggac caagctgacc gtccctag 337

<210> SEQ ID NO 94
 <211> LENGTH: 112
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 94

Gln Ser Val Leu Thr Gln Leu Thr Gln Pro Pro Ser Val Ser Leu Ala
 1 5 10 15
 Pro Gly Gln Thr Ala Thr Ile Thr Cys Gly Gly Asp Asn Ile Gly Arg
 20 25 30
 Lys Ser Val His Trp Tyr Gln Gln Lys Pro Gly Gln Ala Pro Val Leu
 35 40 45
 Val Val Tyr Asp Asp Thr Asp Arg Pro Ser Gly Ile Pro Glu Arg Phe
 50 55 60
 Ser Gly Ser Asn Ser Gly Asn Thr Ala Thr Leu Thr Ile Ser Arg Val
 65 70 75 80
 Glu Ala Gly Asp Glu Ala Asp Tyr Tyr Cys Gln Val Trp Asp Ser Ser
 85 90 95

-continued

Ile Asp His Ser Trp Val Phe Gly Gly Gly Thr Lys Leu Thr Val Leu
 100 105 110

<210> SEQ ID NO 95
 <211> LENGTH: 5
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 95

Asn Tyr Gly Met His
 1 5

<210> SEQ ID NO 96
 <211> LENGTH: 17
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 96

Val Ile Ser Tyr Asp Gly Ser Asn Arg Tyr Tyr Ala Asp Ser Val Lys
 1 5 10 15

Gly

<210> SEQ ID NO 97
 <211> LENGTH: 8
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 97

Asp Ala Gly Gly Pro Leu Asp Tyr
 1 5

<210> SEQ ID NO 98
 <211> LENGTH: 11
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 98

Gly Gly Asp Asn Ile Gly Arg Lys Ser Val His
 1 5 10

<210> SEQ ID NO 99
 <211> LENGTH: 7
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 99

Asp Asp Thr Asp Arg Pro Ser
 1 5

<210> SEQ ID NO 100
 <211> LENGTH: 12
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

-continued

<400> SEQUENCE: 100

Gln Val Trp Asp Ser Ser Ile Asp His Ser Trp Val
 1 5 10

<210> SEQ ID NO 101

<211> LENGTH: 363

<212> TYPE: DNA

<213> ORGANISM: Artificial Sequence

<220> FEATURE:

<223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 101

caggtgcagc tgggtggagtc tgggggagggc gtggtccagc ctgggaggtc cctgagactc 60
 tcctgtgcag cctctggatt caccttcagt agctatggca tgcactgggt ccgccaggct 120
 ccaggcaagg ggctggagtg ggtggcagtt atatcatatg atggaagtat taaatactat 180
 gcagactccg tgaagggccg attcaccatc tccagagaca attccaggaa cacgctgtat 240
 ctgcagatga acagcctgag acctgaggac acggctgttt attactgtgc gaaagattgg 300
 ggatttagcg gctccctaac atttgattat tggggccaag ggacaatggt caccgtctcg 360
 agt 363

<210> SEQ ID NO 102

<211> LENGTH: 121

<212> TYPE: PRT

<213> ORGANISM: Artificial Sequence

<220> FEATURE:

<223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 102

Gln Val Gln Leu Val Glu Ser Gly Gly Gly Val Val Gln Pro Gly Arg
 1 5 10 15
 Ser Leu Arg Leu Ser Cys Ala Ala Ser Gly Phe Thr Phe Ser Ser Tyr
 20 25 30
 Gly Met His Trp Val Arg Gln Ala Pro Gly Lys Gly Leu Glu Trp Val
 35 40 45
 Ala Val Ile Ser Tyr Asp Gly Ser Ile Lys Tyr Tyr Ala Asp Ser Val
 50 55 60
 Lys Gly Arg Phe Thr Ile Ser Arg Asp Asn Ser Arg Asn Thr Leu Tyr
 65 70 75 80
 Leu Gln Met Asn Ser Leu Arg Pro Glu Asp Thr Ala Val Tyr Tyr Cys
 85 90 95
 Ala Lys Asp Trp Gly Phe Ser Gly Ser Leu Thr Phe Asp Tyr Trp Gly
 100 105 110
 Gln Gly Thr Met Val Thr Val Ser Ser
 115 120

<210> SEQ ID NO 103

<211> LENGTH: 324

<212> TYPE: DNA

<213> ORGANISM: Artificial Sequence

<220> FEATURE:

<223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 103

tcctatgtgc tgactcagcc accctcagtg tcagtggccc caggaaagac ggccaggatt 60
 acctgtgggg gaaacaacat tggaagtaaa agtgtgcact ggtaccagca gaagccaggc 120
 caggcccctg tgctggtcat ctattatgat agcgaccggc cctcagggat cctgagcga 180

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ttctctggct ccaactctgg gaacacggcc acctgacca tcagcagggt cgaagccggg 240
gatgaggccg actattactg tcaggtgtgg gatagtagta gtgatcatgt ggtattcggc 300
ggagggacca aggtcacctg ccta 324

```

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<210> SEQ ID NO 104
<211> LENGTH: 108
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: chemically synthesized

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<400> SEQUENCE: 104

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Ser Tyr Val Leu Thr Gln Pro Pro Ser Val Ser Val Ala Pro Gly Lys
1           5           10           15
Thr Ala Arg Ile Thr Cys Gly Gly Asn Asn Ile Gly Ser Lys Ser Val
                20           25           30
His Trp Tyr Gln Gln Lys Pro Gly Gln Ala Pro Val Leu Val Ile Tyr
                35           40           45
Tyr Asp Ser Asp Arg Pro Ser Gly Ile Pro Glu Arg Phe Ser Gly Ser
                50           55           60
Asn Ser Gly Asn Thr Ala Thr Leu Thr Ile Ser Arg Val Glu Ala Gly
65           70           75           80
Asp Glu Ala Asp Tyr Tyr Cys Gln Val Trp Asp Ser Ser Ser Asp His
                85           90           95
Val Val Phe Gly Gly Gly Thr Lys Val Thr Val Leu
                100           105

```

```

<210> SEQ ID NO 105
<211> LENGTH: 12
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: chemically synthesized

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<400> SEQUENCE: 105

```

```

Asp Trp Gly Phe Ser Gly Ser Leu Thr Phe Asp Tyr
1           5           10

```

```

<210> SEQ ID NO 106
<211> LENGTH: 11
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: chemically synthesized

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```

<400> SEQUENCE: 106

```

```

Gly Gly Asn Asn Ile Gly Ser Lys Ser Val His
1           5           10

```

```

<210> SEQ ID NO 107
<211> LENGTH: 11
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: chemically synthesized

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```

<400> SEQUENCE: 107

```

```

Gln Val Trp Asp Ser Ser Ser Asp His Val Val
1           5           10

```

```

<210> SEQ ID NO 108
<211> LENGTH: 351

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<212> TYPE: DNA
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 108

caggtgcagc tgggtggagtc tgggggaggc gtggctcact ctgggaagtc cctgagactc 60
 tcctgtgcag cctctggatt caccttcagt aactatggca tgcactgggt ccgccaggct 120
 ccaggcaagg ggctggagtg gctggcagtc atatcatatg atgggagtaa tagatactat 180
 gcagactccg tgaagggccg attcaccatc tccagagaca attccaacaa cacgctgaat 240
 ctgcaaatga gcagcctgag agctgaggac acggctctgt attactgtgc gaaagatgcc 300
 ggggggcccgc ttgattactg gggccggggc accctgggtca ccgtctcgag t 351

<210> SEQ ID NO 109
 <211> LENGTH: 117
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 109

Gln Val Gln Leu Val Glu Ser Gly Gly Gly Val Ala His Ser Gly Lys
 1 5 10 15
 Ser Leu Arg Leu Ser Cys Ala Ala Ser Gly Phe Thr Phe Ser Asn Tyr
 20 25 30
 Gly Met His Trp Val Arg Gln Ala Pro Gly Lys Gly Leu Glu Trp Leu
 35 40 45
 Ala Val Ile Ser Tyr Asp Gly Ser Asn Arg Tyr Tyr Ala Asp Ser Val
 50 55 60
 Lys Gly Arg Phe Thr Ile Ser Arg Asp Asn Ser Asn Asn Thr Leu Asn
 65 70 75 80
 Leu Gln Met Ser Ser Leu Arg Ala Glu Asp Thr Ala Leu Tyr Tyr Cys
 85 90 95
 Ala Lys Asp Ala Gly Gly Pro Leu Asp Tyr Trp Gly Arg Gly Thr Leu
 100 105 110
 Val Thr Val Ser Ser
 115

<210> SEQ ID NO 110
 <211> LENGTH: 330
 <212> TYPE: DNA
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 110

tcctatgtgc tgactcagcc accctcgggtg tcagtggccc caggacagat ggccagaatt 60
 acctgtgggg gaaacaacat tggagataaa agtgtgcaat ggtaccagca gaggccaggc 120
 caggcccctc tactggtcgt ctatgatgat agcgaccggc cctcagggat ccctgagcgc 180
 ttctctggct cctactctag gaacacggcc accctgacca tcagcagggt cgaagccggg 240
 gatgaggccg actattactg tcaggtgtgg gatagtagta gtgatcatcc ggaggtggtt 300
 ttcggcggag ggaccaagct gaccgtccta 330

<210> SEQ ID NO 111
 <211> LENGTH: 110
 <212> TYPE: PRT

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<213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 111

Ser Tyr Val Leu Thr Gln Pro Pro Ser Val Ser Val Ala Pro Gly Gln
 1 5 10 15

Met Ala Arg Ile Thr Cys Gly Gly Asn Asn Ile Gly Asp Lys Ser Val
 20 25 30

Gln Trp Tyr Gln Gln Arg Pro Gly Gln Ala Pro Leu Leu Val Val Tyr
 35 40 45

Asp Asp Ser Asp Arg Pro Ser Gly Ile Pro Glu Arg Phe Ser Gly Ser
 50 55 60

Tyr Ser Arg Asn Thr Ala Thr Leu Thr Ile Ser Arg Val Glu Ala Gly
 65 70 75 80

Asp Glu Ala Asp Tyr Tyr Cys Gln Val Trp Asp Ser Ser Ser Asp His
 85 90 95

Pro Glu Val Val Phe Gly Gly Gly Thr Lys Leu Thr Val Leu
 100 105 110

<210> SEQ ID NO 112
 <211> LENGTH: 11
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 112

Gly Gly Asn Asn Ile Gly Asp Lys Ser Val Gln
 1 5 10

<210> SEQ ID NO 113
 <211> LENGTH: 7
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 113

Asp Asp Ser Asp Arg Pro Ser
 1 5

<210> SEQ ID NO 114
 <211> LENGTH: 13
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 114

Gln Val Trp Asp Ser Ser Ser Asp His Pro Glu Val Val
 1 5 10

<210> SEQ ID NO 115
 <211> LENGTH: 360
 <212> TYPE: DNA
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 115

caggtccagc tgggtcagtc tgggggaggc gtggtccagc ctgggaggtc cctgagactc 60

tcctgtgcag cctctggatt caccttcagt acctatggca tgcactgggt ccgccaggct 120

-continued

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ccaggcaagg ggctggagtg ggtggcagtt atatcatatg atggaggtac taaatactat 180
gcagactccg tgaagggccg attcaccatc tccagagaca attccatgaa aacgctctat 240
ctgcaaatga acagcctgag aactgaggac acggctgtgt attactgtgc gaaagatctg 300
ggggacctac ccccgggcct tgactactgg ggccgagggg caatgggtcac cgtctcgagt 360

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<210> SEQ ID NO 116
<211> LENGTH: 120
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: chemically synthesized

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<400> SEQUENCE: 116

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Gln Val Gln Leu Val Gln Ser Gly Gly Gly Val Val Gln Pro Gly Arg
1           5           10           15
Ser Leu Arg Leu Ser Cys Ala Ala Ser Gly Phe Thr Phe Ser Thr Tyr
                20           25           30
Gly Met His Trp Val Arg Gln Ala Pro Gly Lys Gly Leu Glu Trp Val
            35           40           45
Ala Val Ile Ser Tyr Asp Gly Gly Thr Lys Tyr Tyr Ala Asp Ser Val
            50           55           60
Lys Gly Arg Phe Thr Ile Ser Arg Asp Asn Ser Met Lys Thr Leu Tyr
65           70           75           80
Leu Gln Met Asn Ser Leu Arg Thr Glu Asp Thr Ala Val Tyr Tyr Cys
            85           90           95
Ala Lys Asp Leu Gly Asp Leu Pro Pro Gly Leu Asp Tyr Trp Gly Arg
            100          105          110
Gly Thr Met Val Thr Val Ser Ser
            115          120

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<210> SEQ ID NO 117
<211> LENGTH: 321
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: chemically synthesized

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<400> SEQUENCE: 117

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tcctatgagc tgactcagcc accctcagtg tcagtggccc tgggacagac ggccacgatt 60
acctgtgggg ggagcagtat tgagagtaaa agtgtacact ggtaccagga gaagccaggg 120
caggcccttg tcctggtcat ctataaagat tccaaccggc cctctgtgat ccctgagcga 180
ttctctggct ccaactcggg gaacacggcc accctgacca tcggcagagc ccaagccggg 240
gatgaggctg actattactg tcaggtgtgg gacagcagta ctggtgtggt attcggcgga 300
gggaccaagc tgaccgtcct a 321

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<210> SEQ ID NO 118
<211> LENGTH: 128
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: chemically synthesized

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<400> SEQUENCE: 118

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Cys His Glu Met Ile Cys Ala Leu Leu Tyr Ser Tyr Asn Thr His Glu
1           5           10           15
Ser Ile Glx Glu Asp Ser Tyr Glu Leu Thr Gln Pro Pro Ser Val Ser

```


-continued

20	25	30
Val Ala Leu Gly Gln Thr Ala Thr Ile Thr Cys Gly Gly Ser Ser Ile 35 40 45		
Glu Ser Lys Ser Val His Trp Tyr Gln Glu Lys Pro Gly Gln Ala Pro 50 55 60		
Val Leu Val Ile Tyr Lys Asp Ser Asn Arg Pro Ser Val Ile Pro Glu 65 70 75 80		
Arg Phe Ser Gly Ser Asn Ser Gly Asn Thr Ala Thr Leu Thr Ile Gly 85 90 95		
Arg Ala Gln Ala Gly Asp Glu Ala Asp Tyr Tyr Cys Gln Val Trp Asp 100 105 110		
Ser Ser Thr Gly Val Val Phe Gly Gly Gly Thr Lys Leu Thr Val Leu 115 120 125		

<210> SEQ ID NO 119
 <211> LENGTH: 11
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 119

Gly Gly Ser Ser Ile Glu Ser Lys Ser Val His
 1 5 10

<210> SEQ ID NO 120
 <211> LENGTH: 7
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 120

Lys Asp Ser Asn Arg Pro Ser
 1 5

<210> SEQ ID NO 121
 <211> LENGTH: 10
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 121

Gln Val Trp Asp Ser Ser Thr Gly Val Val
 1 5 10

<210> SEQ ID NO 122
 <211> LENGTH: 360
 <212> TYPE: DNA
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 122

cagggtccagt tgggtggagtc tgggggaggc gtggtccagc ctgggaggtc cctgagactc	60
tctctgtgcag cctctggatt caccttcagt acctatggca tgcactgggt ccgccaggct	120
ccaggcaagg ggctggagtg ggtggcagtt atatcatatg atggaggtac taaatactat	180
gcagactccg tgaagggccg attcaccatc tccagagaca attccatgaa aacgctctat	240
ctgcaaatga acagcctgag aactgaggac acggctgtgt attactgtgc gaaagatctg	300

-continued

 ggggacctac ccccgggct tgactactgg ggccagggga caatgggtcac cgtctcgagt 360

<210> SEQ ID NO 123
 <211> LENGTH: 120
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 123

Gln Val Gln Leu Val Glu Ser Gly Gly Gly Val Val Gln Pro Gly Arg
 1 5 10 15
 Ser Leu Arg Leu Ser Cys Ala Ala Ser Gly Phe Thr Phe Ser Thr Tyr
 20 25 30
 Gly Met His Trp Val Arg Gln Ala Pro Gly Lys Gly Leu Glu Trp Val
 35 40 45
 Ala Val Ile Ser Tyr Asp Gly Gly Thr Lys Tyr Tyr Ala Asp Ser Val
 50 55 60
 Lys Gly Arg Phe Thr Ile Ser Arg Asp Asn Ser Met Lys Thr Leu Tyr
 65 70 75 80
 Leu Gln Met Asn Ser Leu Arg Thr Glu Asp Thr Ala Val Tyr Tyr Cys
 85 90 95
 Ala Lys Asp Leu Gly Asp Leu Pro Pro Gly Leu Asp Tyr Trp Gly Gln
 100 105 110
 Gly Thr Met Val Thr Val Ser Ser
 115 120

<210> SEQ ID NO 124
 <211> LENGTH: 333
 <212> TYPE: DNA
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 124

cagtctgtgc tgactcagcc accctcagcg tctgggaccc cggggcagag ggtcaccatc 60
 tcttggtctg gaagcagctc caacatcgga agtaatactg taaactggta ccagcagctc 120
 ccaggagcgg cccccaaact cctcatctat actaataatc agcggcctc aggggtcccc 180
 gaccgattct ctggctcaa gtctggcacc tcagcctccc tggccatcag tgggctccag 240
 tctgaggatg aggctgatta ttactgtgca gcatgggatg acagctcgga gctcgtgtg 300
 gtattcggcg gagggaccaa ggtcaccgtc cta 333

<210> SEQ ID NO 125
 <211> LENGTH: 111
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 125

Gln Ser Val Leu Thr Gln Pro Pro Ser Ala Ser Gly Thr Pro Gly Gln
 1 5 10 15
 Arg Val Thr Ile Ser Cys Ser Gly Ser Ser Ser Asn Ile Gly Ser Asn
 20 25 30
 Thr Val Asn Trp Tyr Gln Gln Leu Pro Gly Ala Ala Pro Lys Leu Leu
 35 40 45
 Ile Tyr Thr Asn Asn Gln Arg Pro Ser Gly Val Pro Asp Arg Phe Ser
 50 55 60

-continued

Gly Ser Lys Ser Gly Thr Ser Ala Ser Leu Ala Ile Ser Gly Leu Gln
65 70 75 80

Ser Glu Asp Glu Ala Asp Tyr Tyr Cys Ala Ala Trp Asp Asp Ser Ser
85 90 95

Glu Pro Arg Val Val Phe Gly Gly Gly Thr Lys Val Thr Val Leu
100 105 110

<210> SEQ ID NO 126
<211> LENGTH: 12
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 126

Ala Ala Trp Asp Asp Ser Ser Glu Pro Arg Val Val
1 5 10

<210> SEQ ID NO 127
<211> LENGTH: 5
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 127

Asp Thr Tyr Met Asn
1 5

<210> SEQ ID NO 128
<211> LENGTH: 16
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 128

Ser Ile Tyr Ser Asp Asp Ser Thr Tyr Tyr Ala Asp Ser Val Lys Gly
1 5 10 15

<210> SEQ ID NO 129
<211> LENGTH: 20
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 129

Asp Lys Glu Tyr Val Thr Ser Thr Gly Gly Ala Tyr Tyr Tyr Phe Tyr
1 5 10 15

Tyr Met Asp Val
20

<210> SEQ ID NO 130
<211> LENGTH: 21
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 130

ctcttctgag atgagttttt g

21

<210> SEQ ID NO 131

-continued

<211> LENGTH: 30
 <212> TYPE: DNA
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 131

ttattattcg caattccttt agttgttcct

30

<210> SEQ ID NO 132
 <211> LENGTH: 10
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 132

Asp Gly Ser Glu Ser Glu Tyr Leu Asp Tyr
 1 5 10

<210> SEQ ID NO 133
 <211> LENGTH: 13
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 133

Thr Gly Ser Ser Gly Ser Ile Ala Ser Asn Tyr Val Gln
 1 5 10

<210> SEQ ID NO 134
 <211> LENGTH: 217
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 134

Asn Phe Met Leu Thr Gln Pro His Ser Val Ser Glu Ser Pro Gly Lys
 1 5 10 15

Thr Val Thr Ile Ser Cys Thr Gly Ser Gly Gly Ser Ile Ala Ser Asn
 20 25 30

Tyr Val Gln Trp Tyr Gln Gln Arg Pro Gly Ser Ser Pro Thr Thr Val
 35 40 45

Ile Tyr Glu Asp Asn Gln Arg Pro Ser Gly Val Pro Asp Arg Phe Ser
 50 55 60

Gly Ser Ile Asp Ser Ser Ser Asn Ser Ala Ser Leu Thr Ile Ser Gly
 65 70 75 80

Leu Lys Thr Glu Asp Glu Ala Asp Tyr Tyr Cys Gln Ser Tyr Asp Pro
 85 90 95

Leu Pro Val Trp Val Phe Gly Gly Gly Thr Lys Leu Thr Val Leu Gly
 100 105 110

Gln Pro Lys Ala Ala Pro Ser Val Thr Leu Phe Pro Pro Ser Ser Glu
 115 120 125

Glu Leu Gln Ala Asn Lys Ala Thr Leu Val Cys Leu Ile Ser Asp Phe
 130 135 140

Tyr Pro Gly Ala Val Thr Val Ala Trp Lys Ala Asp Ser Ser Pro Val
 145 150 155 160

Lys Ala Gly Val Glu Thr Thr Thr Pro Ser Lys Gln Ser Asn Asn Lys
 165 170 175

-continued

Tyr Ala Ala Ser Ser Tyr Leu Ser Leu Thr Pro Glu Gln Trp Lys Ser
 180 185 190

His Arg Ser Tyr Ser Cys Gln Val Thr His Glu Gly Ser Thr Val Glu
 195 200 205

Lys Thr Val Ala Pro Thr Glu Cys Ser
 210 215

<210> SEQ ID NO 135
 <211> LENGTH: 449
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 135

Gln Val Gln Leu Val Glu Ser Gly Gly Gly Val Val Gln Pro Gly Arg
 1 5 10 15

Ser Leu Arg Leu Ser Cys Ala Ala Ser Gly Phe Thr Phe Ser Asn Ser
 20 25 30

Gly Ile His Trp Val Arg Gln Ala Pro Gly Lys Gly Leu Glu Trp Val
 35 40 45

Ala Val Ile Ser Tyr Asp Gly Ser Asn Lys Tyr Tyr Ala Asp Ser Val
 50 55 60

Lys Gly Arg Phe Thr Ile Ser Arg Asp Asn Ser Lys Asn Thr Leu Tyr
 65 70 75 80

Leu Gln Met Asn Ser Leu Arg Ala Glu Asp Thr Ala Val Tyr Tyr Cys
 85 90 95

Ala Arg Leu Arg Asp Asn Ala Glu Tyr Thr Asp Tyr Trp Gly Gln Gly
 100 105 110

Thr Leu Val Thr Val Ser Ser Ala Ser Thr Lys Gly Pro Ser Val Phe
 115 120 125

Pro Leu Ala Pro Ser Ser Lys Ser Thr Ser Gly Gly Thr Ala Ala Leu
 130 135 140

Gly Cys Leu Val Lys Asp Tyr Phe Pro Glu Pro Val Thr Val Ser Trp
 145 150 155 160

Asn Ser Gly Ala Leu Thr Ser Gly Val His Thr Phe Pro Ala Val Leu
 165 170 175

Gln Ser Ser Gly Leu Tyr Ser Leu Ser Ser Val Val Thr Val Pro Ser
 180 185 190

Ser Ser Leu Gly Thr Gln Thr Tyr Ile Cys Asn Val Asn His Lys Pro
 195 200 205

Ser Asn Thr Lys Val Asp Lys Arg Val Glu Pro Lys Ser Cys Asp Lys
 210 215 220

Thr His Thr Cys Pro Pro Cys Pro Ala Pro Glu Leu Leu Gly Gly Pro
 225 230 235 240

Ser Val Phe Leu Phe Pro Pro Lys Pro Lys Asp Thr Leu Met Ile Ser
 245 250 255

Arg Thr Pro Glu Val Thr Cys Val Val Val Asp Val Ser His Glu Asp
 260 265 270

Pro Glu Val Lys Phe Asn Trp Tyr Val Asp Gly Val Glu Val His Asn
 275 280 285

Ala Lys Thr Lys Pro Arg Glu Glu Gln Tyr Asn Ser Thr Tyr Arg Val
 290 295 300

Val Ser Val Leu Thr Val Leu His Gln Asp Trp Leu Asn Gly Lys Glu
 305 310 315 320

-continued

Tyr Lys Cys Lys Val Ser Asn Lys Ala Leu Pro Ala Pro Ile Glu Lys
 325 330 335
 Thr Ile Ser Lys Ala Lys Gly Gln Pro Arg Glu Pro Gln Val Tyr Thr
 340 345 350
 Leu Pro Pro Ser Arg Glu Glu Met Thr Lys Asn Gln Val Ser Leu Thr
 355 360 365
 Cys Leu Val Lys Gly Phe Tyr Pro Ser Asp Ile Ala Val Glu Trp Glu
 370 375 380
 Ser Asn Gly Gln Pro Glu Asn Asn Tyr Lys Thr Thr Pro Pro Val Leu
 385 390 395 400
 Asp Ser Asp Gly Ser Phe Phe Leu Tyr Ser Lys Leu Thr Val Asp Lys
 405 410 415
 Ser Arg Trp Gln Gln Gly Asn Val Phe Ser Cys Ser Val Met His Glu
 420 425 430
 Ala Leu His Asn His Tyr Thr Gln Lys Ser Leu Ser Leu Ser Pro Gly
 435 440 445

Lys

<210> SEQ ID NO 136
 <211> LENGTH: 360
 <212> TYPE: DNA
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 136

gaggtgcagc tgggtgcagtc tgggggagggc gtggtccagc ctgggaggtc cctgagactc 60
 tcctgtgcag cctctggatt caccttcagt agctatggca tgcactgggt ccgccaggct 120
 ccaggcaagg ggctggagtg ggtggcagtt atatcatatg atggaagtaa taaatactat 180
 gcagactccg tgaagggccg attcaccatc tccagagaca attccaagaa cacgctgtat 240
 ctgcaaatga acagcctgag agctgaggac acggctgtgt attactgtgc gaaagacggt 300
 ggctggtagc actggtactt cgatctctgg ggcaggggaa ccttggtcac cgtctcgagt 360

<210> SEQ ID NO 137
 <211> LENGTH: 120
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 137

Glu Val Gln Leu Val Gln Ser Gly Gly Gly Val Val Gln Pro Gly Arg
 1 5 10 15
 Ser Leu Arg Leu Ser Cys Ala Ala Ser Gly Phe Thr Phe Ser Ser Tyr
 20 25 30
 Gly Met His Trp Val Arg Gln Ala Pro Gly Lys Gly Leu Glu Trp Val
 35 40 45
 Ala Val Ile Ser Tyr Asp Gly Ser Asn Lys Tyr Tyr Ala Asp Ser Val
 50 55 60
 Lys Gly Arg Phe Thr Ile Ser Arg Asp Asn Ser Lys Asn Thr Leu Tyr
 65 70 75 80
 Leu Gln Met Asn Ser Leu Arg Ala Glu Asp Thr Ala Val Tyr Tyr Cys
 85 90 95
 Ala Lys Asp Gly Gly Trp Tyr Asp Trp Tyr Phe Asp Leu Trp Gly Arg
 100 105 110

-continued

Gly Thr Leu Val Thr Val Ser Ser
 115 120

<210> SEQ ID NO 138
 <211> LENGTH: 324
 <212> TYPE: DNA
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 138

tcttctgagc tgactcagga cctgatgtg tccgtggcct tgggacagac agtcaggatc 60
 acatgccaag gagacagcct caccagctat tatgcaagct ggtaccagca gaagccagga 120
 caggcccttg tacttgtcat ctctggtaat gacaaccggc cctcagggat cccagaccga 180
 ttctctggct ccaactcagg aaacacagct tccttgacca tcaactggggc tcaggcggaa 240
 gatgcggtg actattactg tggctcccgg gacagcagcg gttaccaagt ggtgttcggc 300
 gcagggacca agctgaccgt ccta 324

<210> SEQ ID NO 139
 <211> LENGTH: 108
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 139

Ser Ser Glu Leu Thr Gln Asp Pro Asp Val Ser Val Ala Leu Gly Gln
 1 5 10 15
 Thr Val Arg Ile Thr Cys Gln Gly Asp Ser Leu Thr Ser Tyr Tyr Ala
 20 25 30
 Ser Trp Tyr Gln Gln Lys Pro Gly Gln Ala Pro Val Leu Val Ile Ser
 35 40 45
 Gly Asn Asp Asn Arg Pro Ser Gly Ile Pro Asp Arg Phe Ser Gly Ser
 50 55 60
 Asn Ser Gly Asn Thr Ala Ser Leu Thr Ile Thr Gly Ala Gln Ala Glu
 65 70 75 80
 Asp Ala Ala Asp Tyr Tyr Cys Gly Ser Arg Asp Ser Ser Gly Tyr Gln
 85 90 95
 Val Val Phe Gly Ala Gly Thr Lys Leu Thr Val Leu
 100 105

<210> SEQ ID NO 140
 <211> LENGTH: 11
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 140

Asp Gly Gly Trp Tyr Asp Trp Tyr Phe Asp Leu
 1 5 10

<210> SEQ ID NO 141
 <211> LENGTH: 11
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 141

-continued

Gln Gly Asp Ser Leu Thr Ser Tyr Tyr Ala Ser
1 5 10

<210> SEQ ID NO 142
<211> LENGTH: 7
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 142

Gly Asn Asp Asn Arg Pro Ser
1 5

<210> SEQ ID NO 143
<211> LENGTH: 11
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 143

Gly Ser Arg Asp Ser Ser Gly Tyr Gln Val Val
1 5 10

<210> SEQ ID NO 144
<211> LENGTH: 324
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 144

tcttctgagc tgactcagga ccttgctgtg tctgtggcct tgggacagac agtcaggatc 60
acatgccaaag gagacagcct cagaagctat tatgcaagct ggtaccagcg gaagccagga 120
caggccccctg tacttgtcat ctatggtaaa aacaaccggc cctcagggat cccagaccga 180
ttctctggct ccagctcagg aaacacagct tccttgacca tcaactggggc tcaggcggaa 240
gatgaggctg actattactg taactcccgg gacagcagtg gtaaccatgt gcttttcggc 300
ggagggacca agctgaccgt ccta 324

<210> SEQ ID NO 145
<211> LENGTH: 108
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 145

Ser Ser Glu Leu Thr Gln Asp Pro Ala Val Ser Val Ala Leu Gly Gln
1 5 10 15
Thr Val Arg Ile Thr Cys Gln Gly Asp Ser Leu Arg Ser Tyr Tyr Ala
20 25 30
Ser Trp Tyr Gln Arg Lys Pro Gly Gln Ala Pro Val Leu Val Ile Tyr
35 40 45
Gly Lys Asn Asn Arg Pro Ser Gly Ile Pro Asp Arg Phe Ser Gly Ser
50 55 60
Ser Ser Gly Asn Thr Ala Ser Leu Thr Ile Thr Gly Ala Gln Ala Glu
65 70 75 80
Asp Glu Ala Asp Tyr Tyr Cys Asn Ser Arg Asp Ser Ser Gly Asn His
85 90 95

-continued

Val Leu Phe Gly Gly Gly Thr Lys Leu Thr Val Leu
 100 105

<210> SEQ ID NO 146
 <211> LENGTH: 93
 <212> TYPE: PRT
 <213> ORGANISM: Homo sapiens

<400> SEQUENCE: 146

Asn Phe Met Leu Thr Gln Pro His Ser Val Ser Glu Ser Pro Gly Lys
 1 5 10 15
 Thr Val Thr Ile Ser Cys Thr Arg Ser Ser Gly Ser Ile Ala Ser Asn
 20 25 30
 Tyr Val Gln Trp Tyr Gln Gln Arg Pro Gly Ser Ser Pro Thr Thr Val
 35 40 45
 Ile Tyr Glu Asp Asn Gln Arg Pro Ser Gly Val Pro Asp Arg Phe Ser
 50 55 60
 Gly Ser Ile Asp Ser Asn Ser Ala Ser Leu Thr Ile Ser Gly Leu Lys
 65 70 75 80
 Thr Glu Asp Glu Ala Asp Tyr Tyr Cys Gln Ser Tyr Asp
 85 90

<210> SEQ ID NO 147
 <211> LENGTH: 77
 <212> TYPE: PRT
 <213> ORGANISM: Homo sapiens

<400> SEQUENCE: 147

Val Pro Leu Ser Arg Thr Val Arg Cys Thr Cys Ile Ser Ile Ser Asn
 1 5 10 15
 Gln Pro Val Asn Pro Arg Ser Leu Glu Lys Leu Glu Ile Ile Pro Ala
 20 25 30
 Ser Gln Phe Cys Pro Arg Val Glu Ile Ile Ala Thr Met Lys Lys Lys
 35 40 45
 Gly Glu Lys Arg Cys Leu Asn Pro Glu Ser Lys Ala Ile Lys Asn Leu
 50 55 60
 Leu Lys Ala Val Ser Lys Glu Arg Ser Lys Arg Ser Pro
 65 70 75

<210> SEQ ID NO 148
 <211> LENGTH: 77
 <212> TYPE: PRT
 <213> ORGANISM: Macaca fascicularis

<400> SEQUENCE: 148

Ile Pro Leu Ser Arg Thr Val Arg Cys Thr Cys Ile Ser Ile Ser Asn
 1 5 10 15
 Gln Pro Val Asn Pro Arg Ser Leu Glu Lys Leu Glu Ile Ile Pro Pro
 20 25 30
 Ser Gln Phe Cys Pro His Val Glu Ile Ile Ala Thr Met Lys Lys Lys
 35 40 45
 Gly Glu Lys Arg Cys Leu Asn Pro Glu Ser Lys Ala Ile Lys Asn Leu
 50 55 60
 Leu Lys Ala Val Ser Lys Glu Arg Ser Lys Arg Ser Pro
 65 70 75

<210> SEQ ID NO 149
 <211> LENGTH: 77
 <212> TYPE: PRT

-continued

<213> ORGANISM: *Macaca mulatta*

<400> SEQUENCE: 149

Ile Pro Leu Ser Arg Thr Val Arg Cys Thr Cys Ile Ser Ile Ser Asn
 1 5 10 15
 Gln Pro Val Asn Pro Arg Ser Leu Glu Lys Leu Glu Ile Ile Pro Pro
 20 25 30
 Ser Gln Phe Cys Pro His Val Glu Ile Ile Ala Thr Met Lys Lys Lys
 35 40 45
 Gly Glu Lys Arg Cys Leu Asn Pro Glu Ser Lys Ala Ile Lys Asn Leu
 50 55 60
 Leu Lys Ala Val Ser Lys Glu Arg Ser Lys Arg Ser Pro
 65 70 75

<210> SEQ ID NO 150

<211> LENGTH: 77

<212> TYPE: PRT

<213> ORGANISM: *Oryctolagus cuniculus*

<400> SEQUENCE: 150

Met Pro Leu Ser Arg Thr Val Arg Cys Thr Cys Ile Asn Ile Ser Asn
 1 5 10 15
 Lys Pro Val Asn Pro Arg Ser Leu Glu Lys Leu Glu Ile Ile Pro Ala
 20 25 30
 Ser Gln Ser Cys Ala Asn Val Glu Ile Ile Ala Thr Met Lys Lys Asp
 35 40 45
 Gly Glu Lys Arg Cys Leu Asn Pro Glu Leu Lys Ala Ile Lys Lys Leu
 50 55 60
 Leu Lys Ala Phe Ser Lys Glu Arg Ser Arg Gly Ser Ser
 65 70 75

<210> SEQ ID NO 151

<211> LENGTH: 77

<212> TYPE: PRT

<213> ORGANISM: *Canis familiaris*

<400> SEQUENCE: 151

Ile Pro Leu Ser Arg Thr Ile Arg Cys Thr Cys Ile Lys Ile Ser Asp
 1 5 10 15
 Gln Pro Val Asn Leu Arg Ser Leu Glu Lys Ile Glu Met Ile Pro Ala
 20 25 30
 Ser Pro Ser Cys Pro His Val Glu Ile Ile Ala Thr Met Lys Lys Ser
 35 40 45
 Gly Glu Lys Arg Cys Leu Asn Pro Glu Ser Lys Thr Ile Lys Ser Leu
 50 55 60
 Val Lys Ala Ile Ser Lys Lys Arg Ser Arg Arg Ser Pro
 65 70 75

<210> SEQ ID NO 152

<211> LENGTH: 83

<212> TYPE: PRT

<213> ORGANISM: *Sus scrofa*

<400> SEQUENCE: 152

Ile Pro Leu Ser Arg Thr Val Arg Cys Thr Cys Ile Lys Ile Ser Asp
 1 5 10 15
 Arg Pro Val Asn Pro Arg Ser Leu Glu Lys Leu Glu Met Ile Pro Ala
 20 25 30

-continued

Ser Gln Ser Cys Pro His Val Glu Ile Ile Ala Thr Met Lys Lys Asn
 35 40 45

Gly Glu Lys Arg Cys Leu Asn Pro Glu Ser Lys Ala Ile Lys Asn Leu
 50 55 60

Leu Lys Ala Ile Ser Lys Glu Arg Ser Lys Arg Ser Pro Arg Thr Gln
 65 70 75 80

Arg Glu Ala

<210> SEQ ID NO 153
 <211> LENGTH: 77
 <212> TYPE: PRT
 <213> ORGANISM: Rattus norvegicus

<400> SEQUENCE: 153

Ile Pro Leu Ala Arg Thr Val Arg Cys Thr Cys Ile Asp Phe His Glu
 1 5 10 15

Gln Thr Leu Arg Pro Arg Ala Ile Gly Lys Leu Glu Ile Ile Pro Ala
 20 25 30

Ser Leu Ser Cys Pro His Val Glu Ile Ile Ala Thr Met Lys Lys Asn
 35 40 45

Asn Glu Lys Arg Cys Leu Asn Pro Glu Ser Glu Ala Ile Lys Ser Leu
 50 55 60

Leu Lys Ala Val Ser Gln Arg Arg Ser Lys Arg Ala Pro
 65 70 75

<210> SEQ ID NO 154
 <211> LENGTH: 77
 <212> TYPE: PRT
 <213> ORGANISM: Mus musculus

<400> SEQUENCE: 154

Ile Pro Leu Ala Arg Thr Val Arg Cys Asn Cys Ile His Ile Asp Asp
 1 5 10 15

Gly Pro Val Arg Met Arg Ala Ile Gly Lys Leu Glu Ile Ile Pro Ala
 20 25 30

Ser Leu Ser Cys Pro Arg Val Glu Ile Ile Ala Thr Met Lys Lys Asn
 35 40 45

Asp Glu Gln Arg Cys Leu Asn Pro Glu Ser Lys Thr Ile Lys Asn Leu
 50 55 60

Met Lys Ala Phe Ser Gln Lys Arg Ser Lys Arg Ala Pro
 65 70 75

<210> SEQ ID NO 155
 <211> LENGTH: 83
 <212> TYPE: PRT
 <213> ORGANISM: Capra hircus

<400> SEQUENCE: 155

Ile Pro Leu Ser Arg Asn Thr Arg Cys Thr Cys Ile Glu Ile Ser Asn
 1 5 10 15

Gly Ser Val Asn Pro Arg Ser Leu Glu Lys Leu Glu Leu Ile Pro Ala
 20 25 30

Ser Gln Ser Cys Pro Arg Val Glu Ile Ile Ala Thr Met Lys Arg Asn
 35 40 45

Gly Glu Lys Arg Cys Leu Asn Pro Glu Ser Lys Thr Ile Lys Asn Leu
 50 55 60

Leu Lys Ala Ile Asn Lys Gln Arg Thr Lys Arg Ser Pro Arg Thr Arg
 65 70 75 80

-continued

Lys Glu Ala

<210> SEQ ID NO 156
 <211> LENGTH: 73
 <212> TYPE: PRT
 <213> ORGANISM: Sigmodon hispidus

<400> SEQUENCE: 156

```

Ile Pro His Ser Arg Thr Val Arg Cys Phe Cys Asn Lys Thr Glu Asp
1           5           10           15
Arg Leu Leu Arg Pro Arg Ala Leu Glu Lys Leu Glu Ile Ile Pro Ala
          20           25           30
Ser Leu Ser Cys Pro Arg Met Glu Ile Ile Ala Thr Met Lys Lys Thr
          35           40           45
Glu Lys Lys Arg Cys Leu Asn Pro Glu Ser Ala Ala Ile Lys Asn Leu
          50           55           60
Leu Lys Glu Ile Ser Arg Lys Asn Val
65           70
  
```

<210> SEQ ID NO 157
 <211> LENGTH: 77
 <212> TYPE: PRT
 <213> ORGANISM: Cricetus cricetus

<400> SEQUENCE: 157

```

Ile Pro Leu Ser Arg Thr Val Arg Cys Ser Cys Ile Lys Ile Asp Asp
1           5           10           15
Arg Pro Val Lys Pro Arg Ala Leu Gly Lys Leu Glu Ile Ile Pro Ala
          20           25           30
Ser Gln Ser Cys Pro Arg Val Glu Ile Ile Val Thr Met Lys Lys Thr
          35           40           45
Glu Glu Lys Arg Cys Leu Asn Pro Glu Ser Glu Ala Ile Lys Ser Leu
          50           55           60
Leu Lys Ala Val Ser Gln Arg Arg Ser Lys Arg Ala Ser
65           70           75
  
```

<210> SEQ ID NO 158
 <211> LENGTH: 11
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: chemically synthesized

<400> SEQUENCE: 158

```

Asn Ser Arg Asp Ser Ser Gly Asn His Val Leu
1           5           10
  
```

What is claimed is:

1. An isolated fully human monoclonal antibody that binds interferon-inducible protein-10 (IP-10) or an antigen-binding fragment thereof, wherein said antibody comprises:

- (a) a VH CDR1 region comprising the amino acid sequence of SEQ ID NO: 5;
- (b) a VH CDR2 region comprising the amino acid sequence of SEQ ID NO: 6;
- (c) a VH CDR3 region comprising the amino acid sequence of SEQ ID NO: 7;
- (d) a VL CDR1 region comprising the amino acid sequence of SEQ ID NO: 8;

- 55 (e) a VL CDR2 region comprising the amino acid sequence of SEQ ID NO: 9; and
- (f) a VL CDR3 region comprising the amino acid sequence of SEQ ID NO: 10.
2. The antibody of claim 1, wherein said antibody is an IgG isotype.
3. The antibody of claim 1, wherein said antibody is an IgG1 isotype.
4. The antibody of claim 1, wherein said antibody comprises a heavy chain variable sequence comprising the amino acid sequence of SEQ ID NO:2 and a light chain variable sequence comprising the amino acid sequence of SEQ ID NO:4.

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5. An isolated fully human monoclonal anti-IP-10 antibody comprising a heavy chain sequence comprising the amino acid sequence of SEQ ID NO: 134 and a light chain sequence comprising the amino acid sequence of SEQ ID NO: 135.

6. The antibody of claim **5**, wherein said antibody is an IgG1 isotype.

7. An isolated fully human monoclonal antibody, wherein said antibody comprises the heavy chain variable amino acid sequence of SEQ ID NO: 2, wherein said antibody binds IP-10.

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8. The antibody of claim **7**, wherein said antibody further comprises the light chain variable amino acid sequence SEQ ID NO: 4, wherein said antibody binds IP-10.

9. The antibody of claim **8**, wherein said antibody is an IgG isotype.

10. The antibody of claim **9**, wherein said antibody is an IgG1 isotype.

11. A pharmaceutical composition comprising an antibody of any one of claim **1**, **5**, or **7** and a carrier.

* * * * *